FACTORY
MANAGEMENT and MAINTENANCE

March, 1935

L. C. MORROW
Editor

NRA Automotive Report

TWO major impressions are created by a reading of the NRA Research Report on the automobile industry. One is that automobile manufacturers have taken full advantage of technological development. The other is that they have been negligent of human relationships.

On the first score there can be no quarrel. It was the adoption of technological developments that made it possible to sell better cars cheaper in spite of higher rates for labor and materials. And it was necessary to do that job in leading the country out of depression.

For its neglect of human relationships in the past there can be found some valid excuse. The industry has grown up on a basis of keen competition, peak and valley sales, and continuous production. Necessarily there has been a spirit of drive inimical to long and placid tenure of jobs. It is not uncommon for a new industrial giant to wear out its creators as it grows.

That the employee conditions recounted in the report shall continue, is unthinkable. American industry has no place for Legrees in its foreman ranks. Nor will it accept the practice of speeding up equipment beyond the endurance of workers. No buyer wants to feel that his car is a product of sweatshop labor.

However, final judgment must be withheld. The extent of malpractice in dealing with workers is not known. The report does not pretend to say—admits an inconclusive number of witnesses, although recognizing their obvious truthfulness. There is enough smoke to prove the existence of a fire.

On the whole, the investigation has been very much for the good of the country. It indicates the path that can be taken to stabilize a very important industry. It shows again the necessity for management to set up and abide by policies of fair practice in dealing with employees. It proves, indirectly, that a share-the-work program must necessarily result in lowered annual incomes for workers.

More important, for the moment, than all of these, the report has made available proof that low prices mean wide distribution; that low prices depend largely upon low manufacturing costs; that by means of technological development in equipment and methods low manufacturing costs can be obtained.

If every industry were to do its utmost by reducing its manufacturing costs and by aggressive selling, at the same time really solving its labor relations problems, the acceleration to recovery would be remarkable.

Social Security Act

INDUSTRY is giving far too little attention to the Wagner-Lewis-Doughton Act now under consideration by Congress. At the hearings now being concluded, industry has not been represented by any considerable number of spokesmen. Yet industry is going to foot most of the bill.

A surprising proportion of industry has not reached conclusions. In the meantime Congress is making up its mind. Granted that the bill is cumbersome and that thirty days is too short a time for consideration by industry of what it took experts four months and more to prepare. The fact remains that the administration is trying to push the legislation through. Which means that industry should at least get up on its hind legs and shout for more time.

What size bill will industry have to pay? Eventually the tax will be 5½ per cent of payroll; almost immediately it will be 3 per cent.

And here's how big 3 per cent is. In the year of greatest prosperity, 1929, the average net income for the manufacturing industries was 6.8 per cent of total income. A 3 per cent tax on the payrolls of that year would have been equivalent to an 11.7 per cent tax on net profits.

That's average for the manufacturing industries. But in some industries the proportion of payroll cost to total cost is much higher than average. In business publishing, for example, a 3 per cent tax on payrolls in 1934

would have been equivalent to a 26 per cent tax on net income.

These are startling figures. They indicate that industry may soon be saddled with a burden that it can't well absorb, can't pass on readily.

It's all well and good to agree with the objectives of social security legislation—and most of industry does—but there is no justification for jumping into it pell-mell, with the likelihood of endangering what little recovery we have.

Our suggestion is that industry, by groups and by plants, immediately figure out its own added costs, according to the bill, and then say something about them to its Congressmen.

We'd like to see separate bills for old age pensions and unemployment compensation. We want them taken up singly, with plenty of time for actuarial study. We can't agree with all the haste.

Incentives That Irritate

WHEN incentive plans go wrong it is often because they disregard the natural reactions of the men to whom they apply.

Most employers will admit the economic precariousness of the average workman's life. The natural reaction to that insecurity is to live in the present and let the future take care of itself. Schwab and Chrysler won their way up from the work bench, but few workmen stake their lives in the belief that they will do likewise.

That does not prevent their taking a real pride and pleasure in their work, or developing a real loyalty to the boss. But they are not willing to sacrifice peace of mind for a money incentive that all too often in the past has disappeared after a few months.

The rate setter often finds it hard to understand such indifference. He himself is building a career. He labors with the recalcitrants, tries contests, posts bonus scores. But a slow discomfort and resentment spreads.

Workmen will respond to incentives. That is abundantly proved. They will respond to the logic of a well-organized attack on waste and inefficiency. They resent and will ultimately rebel against prodding. There is no incentive formula that can be safely applied by a man who does not understand the reservations that exist in the average working man's mind, and the part that feelings, rather than logic, play in his conduct and reactions.

Let Suitability, Not Cost, Prevail in Lubrication

MANY who control the purchase of lubricants believe that when they have secured products of lower cost they have performed a useful service. True, savings are often possible through the use of lower-priced lubricants for certain services, but a saving in initial cost does not always mean ultimate economies.

Cost of lubricants is usually a small item in total operating costs, and is only one of the expenses involved in lubrication. It includes such items as power waste, maintenance and oiling labor costs, and production losses resulting from shutdowns due to bearing failures. Other losses are incurred when products have to be rejected because of oil stains caused by faulty or excessive lubrication.

Conversely, reducing lubrication costs does not always mean lower-priced lubricants. In many instances the use of a higher grade, more suitable oil will result in ultimate savings.

The answer to the whole problem of securing maximum over-all efficiency in lubrication lies, then, in determining by careful study the kind and quality of lubricant, and the method of application that is best suited to each case.

He'll get the bellyache if she makes him eat it all at once

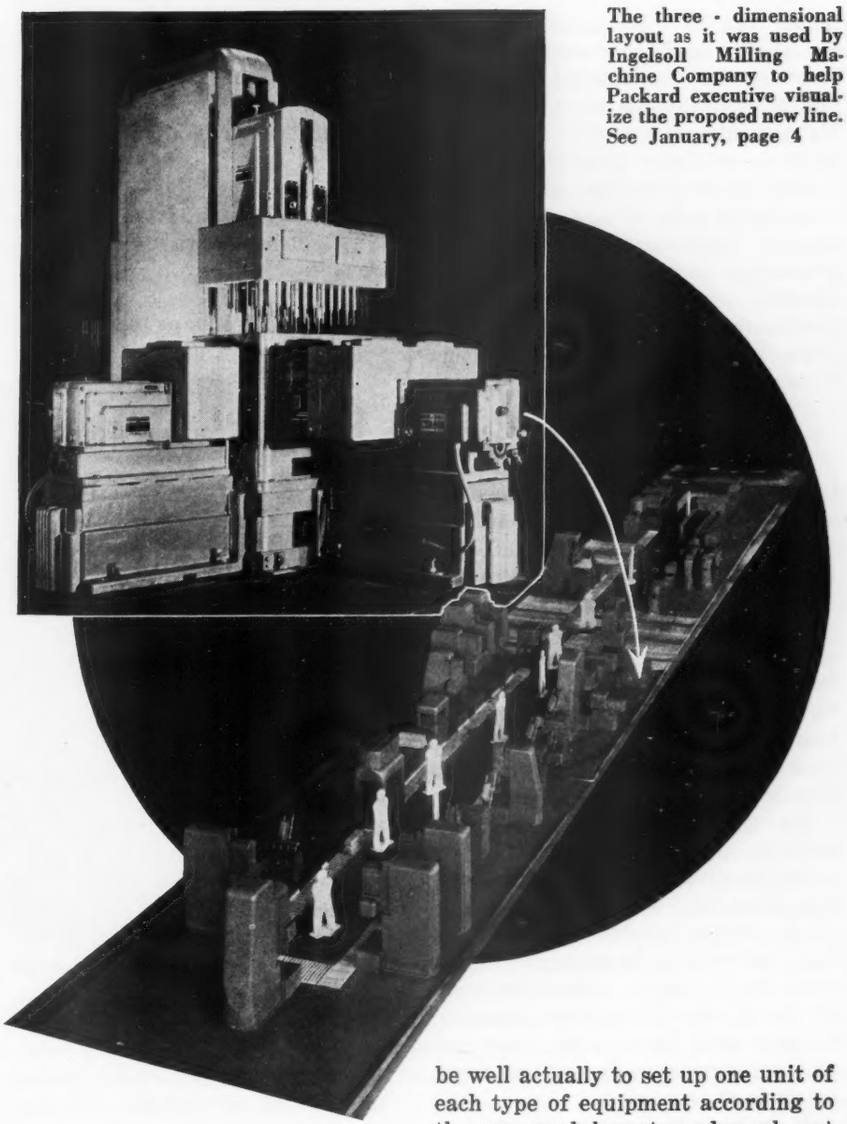
Selling the New Layout

Last, by no means least, often the hardest, part of the job. No use planning new layouts if you can't sell them to the management

ALLAN H. MOGENSEN
Consulting Editor

WHEN the templet layout is completed the next step is to sell it. Any new layout, to be successful, must be sold not only to the management, who must decide whether the return will justify the expenditure necessary, but also to the men who will have to operate it.

It is here that the process chart method has distinct advantages over any other approach. Process charts, showing old and new methods, cannot help but impress anyone with the advantage of the new method over the old. Place the chart shown in the first of these four articles (December, page 539) next to the one for the proposed method (January, page 16), and an immediate visual impression is created. One is three times as long as the other. Likewise, the maze of lines showing backtracking on the flow diagram, contrasted with the new simple flow, demands *attention.*



The three - dimensional layout as it was used by Ingelsoll Milling Machine Company to help Packard executive visualize the proposed new line. See January, page 4

Make Them Want It

Sales experts tell us that this is the first step in making a sale. The second is to create *interest.* The summaries, indicating number of operators eliminated, saving in distance traveled, and reduction in number of storages or delays, will do this. The templet layout, showing to actual scale how the new department or plant will appear, will also secure this interest.

Actual *desire,* however, must be developed. To do this, the savings must be translated wherever possible into dollars and cents. All items must be considered. Reduced manufacturing interval can be expressed in terms of reduction in working capital required. Although industry has in recent years made considerable progress in increased turnover, comparison with that attained in automotive, radio, and refrigerator plants may convince one that there is still much to be done.

Reduction in direct labor should be determined from the time-study data, if available. If not, certain trial studies in various departments may be made, the savings determined; with a suitable factor of safety, the ratio may be applied to the total amount spent for direct labor.

Of course, if operations are duplicated in many similar units, it may be well actually to set up one unit of each type of equipment according to the proposed layout, and work out the details so that accurate studies under actual operating conditions will give reliable cost figures. It is here, though, that formulas and charts used for setting synthetic standards will prove their value, and a good time-study department will more than justify its existence.

Direct labor savings will be secured through proper grouping of machines, elimination of handling

and trucking, and combination of various operations. Such savings will usually run from 10 to 30 per cent, if the layout is properly made.

Savings in indirect labor are often harder to determine, but nevertheless should be carefully studied. If a layout is changed from one of process control to product control, the whole type of supervision may have to be altered.

Emphasis may shift from functional type of organization to line and staff. Inspection methods may be changed from centralized inspection points to inspection on the job. Many plants are finding it worth while to establish inspection points in the line of work flow, rather than trucking all parts to some central inspection department. In fact, if production control is set up, such inspection methods are essential to moving the work through the operations without any bank between them.

It's Control That Counts

Modern gaging methods, and new types of equipment, often gaging automatically, are changing many of our older ideas—the essential difference being that we are more interested in *quality control* than inspection. Control that prevents errors from being made or corrects them while the work is being performed is far superior to an inspection system that merely catches, classifies, and records errors after they have occurred.

Tool-setting and machine-setting methods may be entirely altered, with possible savings. Full consideration must be given to handling stock, stores, service supplies, and tools, as well as to methods of machine maintenance. Actual analyses of the number of truckers necessary to move work through the plant and of other service people required must be made at this point.

It is here that selling the layout to the operating group is essential. It would be difficult to go into this phase of the analysis without the actual cooperation of all concerned. For this reason, the most successful method is to bring the foremen, assistant foremen, and division heads into the layout job at the start. They can assist in drawing up the process charts of the present method.

In some instances a product is assigned, and each department undertakes to complete all parts of the chart that occurred within that section. These parts are assembled into a complete chart, and then the four questions (see January article) are asked by holding meetings with all concerned.

Much more rapid and better progress is achieved in such groups than by one man or a few men acting individually. Suggestions are made by members of the group, and even though only a few worthwhile improvements may be suggested by an assistant foreman, he nevertheless feels that he has an active part in the layout. This is most important! He feels that he has been considered, and when his group has agreed that a certain change can be made, he will do his best to see that it does work when the time comes.

Motion-Economized Layout

in four quick chapters

I

Now Look at Layout
December, page 538

II

From 59 Steps to 22
January, page 16

III

Next, the Templet Layout
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IV

Selling the Layout
In this issue

For Example

In one plant, typical daily production runs of all possible varieties and combinations of product were set up. Process charts had been made, the new methods set up, the templet layout completed, and then each foreman and supervisor went to work. Given any needed information by the time-study department, he figured out just how many men were needed to operate the new department for the various conditions. These were not guesses, but actually included consideration of such items as walking time between machines, best location of all supplies and accessory materials, and actual scheduling of materials to the plant.

To some this might seem like an unnecessary amount of detail, but it is worth mentioning that when the actual layout was completed, it followed the move schedule to the day, fell into production with the least amount of delay, and has come so close to hitting the estimated savings right on the nose that unless you actually saw the job, you might think it some theorist's dream.

Foreman Can Make or Break

When a foreman goes on record in such detail, and has worked it out on a process chart basis, he is going to do his level best to see that it clicks. On the other hand, if he has nothing to do with a layout that is being made by some expert, he can usually find plenty of reasons why it won't work.

It is human nature to resist anything new, and to resent criticism. Often this prevents new plant layouts from being effective. One may buy new equipment, move into a new plant, put in new processes, but a plant must also have new ideas on the part of its foremen and division heads.

One manufacturer, when he made a major move involving a new building, brand-new equipment in many instances, and several radically new methods in the whole method of manufacturing the product, realized that his foremen had been in the old surroundings so long that they would have considerable difficulty in accepting the new conditions. He took them on a trip to plants in several of the newer industries, and when they returned, they had seen so many things being done which they knew could not be done, that some of them felt they had not gone far enough.

Now it is not always possible or practical to take your foremen on such a trip. Having them in on layout meetings, however, gives them a chance to obtain a broader view of the whole plant problem, and also to get an idea of what is going on outside. Bring in two or three materials handling engineers, some equipment and tool salesmen, a few plant foremen and division heads, and

(Continued on advertising page 58)

Steam Costs Are What Count

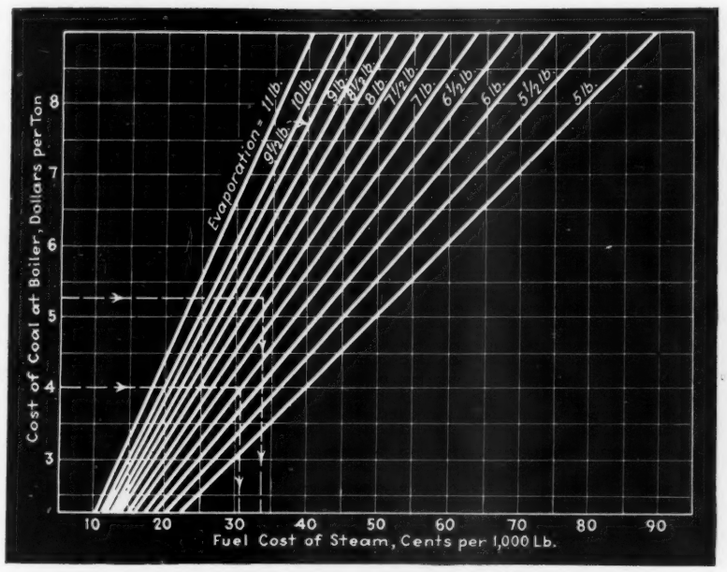
They can be kept low by selecting firing equipment that will handle cheap fuel and still render the service required

OTTOMAR H. HENSCHEL
Geerlings and Henschel, Engineers
Milwaukee

HAND-FIRED boiler plants are the exception rather than the rule. In spite of that fact, there are a great many incorrectly applied stokers in operation.

Enthusiasm and desire to make a sale has sometimes led to the installation of units that have barely enough coal burning capacity, and hence are suitable for burning only the highest grade of fuel. As a consequence the purchaser does not secure such advantages as maximum steam generation consistent with the actual capacity of the boiler, and the savings frequently made possible by the use of lower grades of coal. Attempts to force the unit beyond capacity invariably result in frequent breakdowns, early burning out of tuyere blocks, and rapid deterioration of settings, with consequent heavy maintenance and replacement costs.

Reputable stoker manufacturers, of course, insist that their equipment be properly applied and installed. Careful study is made of all conditions to make it possible for the plant owner to use fuel that will produce steam at minimum cost.



Fuel cost of steam for various coal prices and rates of evaporation

Finding Unit Cost of Steam

Cost of coal burned annually in an industrial plant has little significance; it is the cost of steam that is important. When costs are based on the number of cents' worth of coal used to generate 1,000 lb. of steam, seasonal and other variations in steam requirements may be disregarded. In addition, this basis will serve as a ready means of determining the relative worth of different coals.

In some plants that use hand-firing it may be possible to evaporate and turn into steam only, say, 5 or 6 lb. of water per pound of coal fired. With stoker firing, 9 or 10 lb. of steam may be produced. Obviously, the cost of steam is dependent upon the rate of evaporation and the cost of coal delivered to the boiler room.

Assume that coal costs $5 per ton, delivered, and that the average rate of evaporation is 8 lb. of water per pound of coal burned. Each 1,000 lb. of water evaporated (1,000 lb. of steam produced) will require the burning of 1,000 ÷ 8 = 125 lb. of coal. At $5 per ton the coal costs 0.25c. per pound. Therefore, the coal cost for steam is 125 × 0.25 = 31.25c. per thousand pounds.

To eliminate calculations, the accompanying chart has been prepared. It covers a wide range of coal costs and rates of evaporation: at least, practically all of those encountered in average, everyday practice.

An Easier Way to Do It

For example, assume that coal costs, delivered, $5.25 per ton, the average rate of evaporation is 7¾ lb., and that it is desired to find the coal cost per thousand pounds of steam generated. From the point corresponding to $5.25, at the left of the chart, trace to the right to the diagonal line representing the rate of evaporation—in this instance, 7¾ lb. From this intersection trace vertically downward to the figure 34 at the bottom of the chart, representing a coal cost of 34c. per thousand pounds of steam generated. By actual calculation the cost is found to be 33.86c., which shows the accuracy of the chart.

Comparisons can be made in the same way of steam cost with coals selling at different prices. Suppose it is desired to consider a somewhat lower priced grade of coal, such as that obtainable from the Midwestern fields of Indiana, and costing, say, $4 per ton delivered to the boilers. It is known that because of the lower heat content and other characteristics of this coal, an evaporation of but 6½ lb. of water per pound of coal burned can be realized. What, if anything, may be gained or lost by the use of this fuel?

With the present coal the fuel cost

per thousand pounds of steam generated is 34c. Following the horizontal line corresponding to $4 per ton to the right until it meets the diagonal representing an evaporation value of 6½ lb., and then downward, it will be seen that the fuel cost amounts to slightly less than 31c. per thousand pounds.

Although a unit weight of the cheaper coal is incapable of generating as much steam as the same weight of $5.25 coal, the cost of steam is less with the cheaper coal.

When investigating mechanical fuel-burning equipment, the desirability of selecting a unit that is capable of handling other than the higher priced coals is apparent.

No Rules to Show Savings

In problems of this nature no hard-and-fast rules or formulas can be employed to predetermine savings possible with a certain installation. A few examples, however, will show some of the possibilities.

A 72-in. x 18-ft. horizontal return tubular boiler burning annually about 1,600 tons of coal, costing $5.80 per ton delivered, had been hand-fired. Recently it was equipped with a stoker at a total cost of $2,400.

After this change it was found possible to use coal costing only $4.65 per ton delivered. Tests indicated a new rate of evaporation whereby coal consumption was reduced somewhat more than 10 per cent. The new annual fuel consumption is about 1,440 tons, costing $6,696 per year. The resulting fuel saving is equal to $9,280 — $6,696 = $2,584 a year.

Example: Savings $2,456 a Year

In addition, it was found possible to eliminate a labor charge for helpers' services during the winter months amounting to more than $400, which brought the reduction in cost up to $2,984.

As stated, total installation cost was $2,400, so that fixed charges of $528 should be considered, covering interest on investment, depreciation, taxes, insurance, repairs, and maintenance.

Net savings, then, are about $2,984 — $528 = $2,456 per year. Therefore, the stoker unit more than paid for itself within a year.

Another instance in which the cost of steam per thousand pounds was materially reduced by the use of cheaper coal involved a single-unit boiler plant consisting of a 150-hp., three-drum, low-head, bent-tube type of water tube boiler operating under 165 lb. gage pressure. It was equipped with a side-dump, underfeed type of stoker.

Saving 2.5 Cents a 1,000 Lb.

An Eastern coal of comparatively high heat content and costing $4.85 per ton delivered was used. It was accurately weighed as fired and the boiler output was measured by an indicating, recording, integrating type of steam flow meter. Tests showed an average daily evaporation of 10.05 lb. of water per pound of coal.

This Is the Year

•

For 5 years industry has been letting its plants and buildings go to pot. But this is the year industry will put them in shape.

April *FACTORY* will have a special section on plant maintenance that tells what to do, how to do it, what equipment to do it with

A fourth-vein Indiana coal costing $3.68 per ton delivered was substituted, whereupon an evaporation of 8.5 lb. of water per pound of coal burned was secured. Accordingly, the unit steam costs were: With Eastern coal, (4.85 × 1,000) ÷ (2,000 × 10.05) = 24.1c. per 1,000 lb. of steam; with Midwestern coal, (3.68 × 1,000) ÷ (2,000 × 8.5) = 21.6c. per 1,000 lb. of steam.

Means 10.3 Per Cent Saving

Under test conditions that were believed to be typical of daily operation, use of the Midwestern coal appeared to give a reduction in cost of 2½c. or 10.3 per cent per 1,000 lb. of steam.

Possibilities of savings through correct application of stokers and use of the lower grades of coal were shown in a two-boiler plant. Each unit was rated 150 horsepower. They are of the horizontal return tubular type, and were equipped with lightly constructed stokers that were too small for the duty imposed upon them. Comparatively little overload could be carried. Tuyeres, conveyor screws, and retorts required frequent replacement; hence repair and maintenance charges became so heavy that new stokers were needed in about three years.

A high-grade Eastern coal costing $5.60 delivered was fired. Under favorable conditions, an evaporation of 8.05 lb. was obtained, giving a fuel cost of 34.77c. per thousand pounds of steam.

Carefully Selected Equipment

Specifications were prepared for new firing equipment, special consideration being given to such factors as rugged construction, continuous capacities up to 200 per cent of boiler rating, and high over-all efficiencies at loads up to 200 per cent of rating, when burning 11,000-B.t.u. Illinois or Indiana coals.

Units selected are of the electrically driven, air-zoned, side-dump type, with effective equivalent grate dimensions of 6 ft. x 7 ft. 4½ in. They are fitted with reciprocating combustion grates operated from an automatic valve employed to actuate the main ram, and driven by a 7½-hp. constant-speed motor which also drives a fan capable of delivering 4,300 cu.ft. of air per minute at 4 in. static pressure.

Cuts Cost 18.7 Per Cent

An acceptance test in conformity with the A.S.M.E. code revealed at 192.3 per cent of boiler rating (for the 10-hour test period) an over-all efficiency of 74.2 per cent, 4.1 per cent over the guarantee. For 1 hour, a load equivalent to 268 per cent of boiler rating was successfully carried.

The acceptance test indicated an evaporation of 7.80 lb. of water per pound of coal. A fourth-vein Indiana coal costing $4.41 delivered was used, giving a fuel cost of 28.27c. per thousand pounds of steam.

Thus, good firing equipment burning a low grade of coal has made possible an 18.7 per cent reduction in steam cost.

Best Laid Out Is Best Handled

Conveyors are in, manual handling is out, at the Murray Corporation, where 1935 production schedules called for new layouts. Second of three articles describing them

F. E. WIKANDER
Plant Layout Engineer
Murray Corporation of America, Detroit

IN MY February article I mentioned that rearrangement of the second floor of the press building for rear end assemblies made it necessary to shove a power washing machine and a group of bandsaws downstairs where they logically belonged. There was no particular reason why door assembly should have been on the ground floor next to the presses, so this department was moved to make way for the equipment that naturally served the stamping department.

That Main Line Monorail

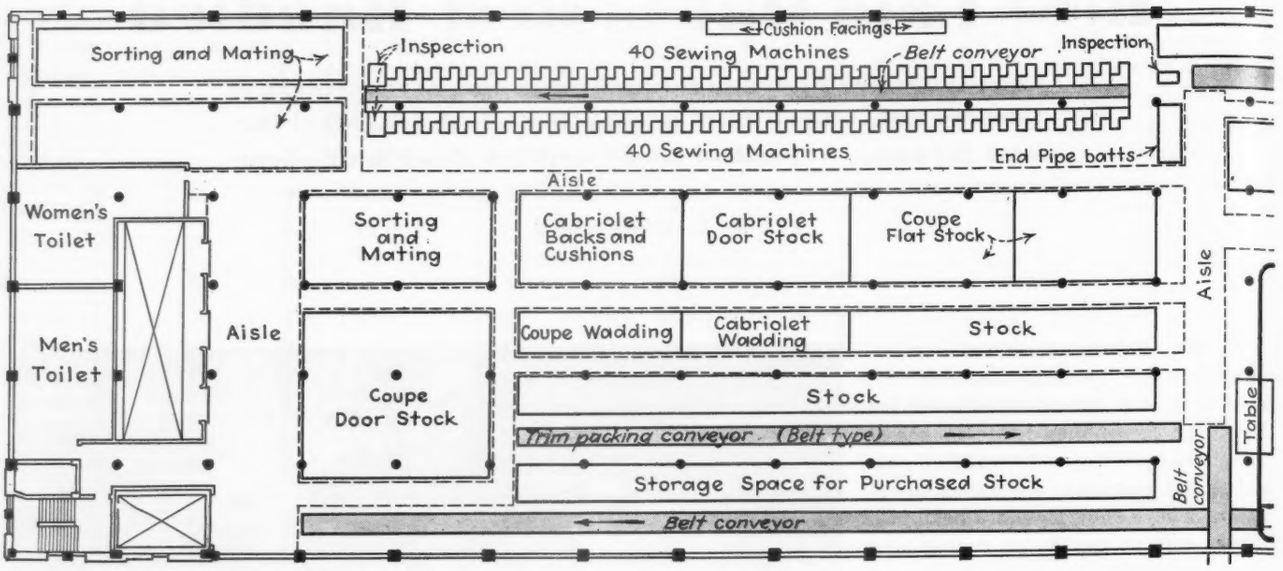
Every advantage was taken in the move to get the most desirable layout. The first consideration was receipt of stampings and delivery of completed doors. Stampings, if small, come up in skid boxes, otherwise on the main line press-room monorail. On its return trip it picks up the assemblies and carries them back to the main transfer point of the plant. (February, page 54). Looped monorails and floor strand conveyors serve intermediate points of fabrication.

Doors for three-window coupes are the biggest production item, and the line is laid out along the west wall in such a way that right- and left-hand door parts are fabricated in parallel. Thus the various machines and welders are equispaced about a longitudinal center line, and the work progresses down the floor in groups of subassemblies.

An overhead monorail lets one subassembly jump the fabricating section of the next one, leap-frog style. For example, inner door panels made in the first section are hung on the monorail and taken off at the assembly bucks at the end of section two where hinge pillar and lock frame subassemblies meet them and are spot welded together. The resulting subassembly is carried

Long lengths of pleatings come off the two big multiple pleating machines in the background and are sheared electrically into individual seat pads on the conveyor in the foreground

Pleated stock is moved to a bank of 80 sewing machines lined up on either side of a belt conveyor



Layout of K-D trim and hardware department

through a set of spot welders and a trim press to the next set of assembly bucks where it meets the outer panel fabricated alongside section one and is taken off the line.

These units are then clinched together in a press prior to welding. Pipe stands are placed at convenient points for resting subassemblies in temporary reserve.

At the south end of the line are three work-type conveyors, of single-strand design, on which the metal finishing operations are performed. A linear speed of five to six feet a minute permits filing, disk grinding, and peripheral grinding as the work progresses through the department.

In the middle of the room are other assembly groups for cabriolet, roadster, and phaeton doors—modifications of the coupe door line because of the limited production involved. Over against the east wall is a separate line for assembling the stampings of rear deck doors. Here spot welders and riveters are placed side by side so that the work can be handed down the line.

Cloth Trim Layout

An example of rearrangement where the purpose is to provide large banks of raw and semi-finished materials in process, as well as a straight line flow, is found in the cloth trim and hardware department. The layout is shown in the figure. This is another floor that has been completely changed around. The key units are the two multipleaters—large, intricate, automatic sewing machines of tremendous productive capacity, so large that huge banks of stock are required to keep their hungry maws filled.

No Backtracking Here

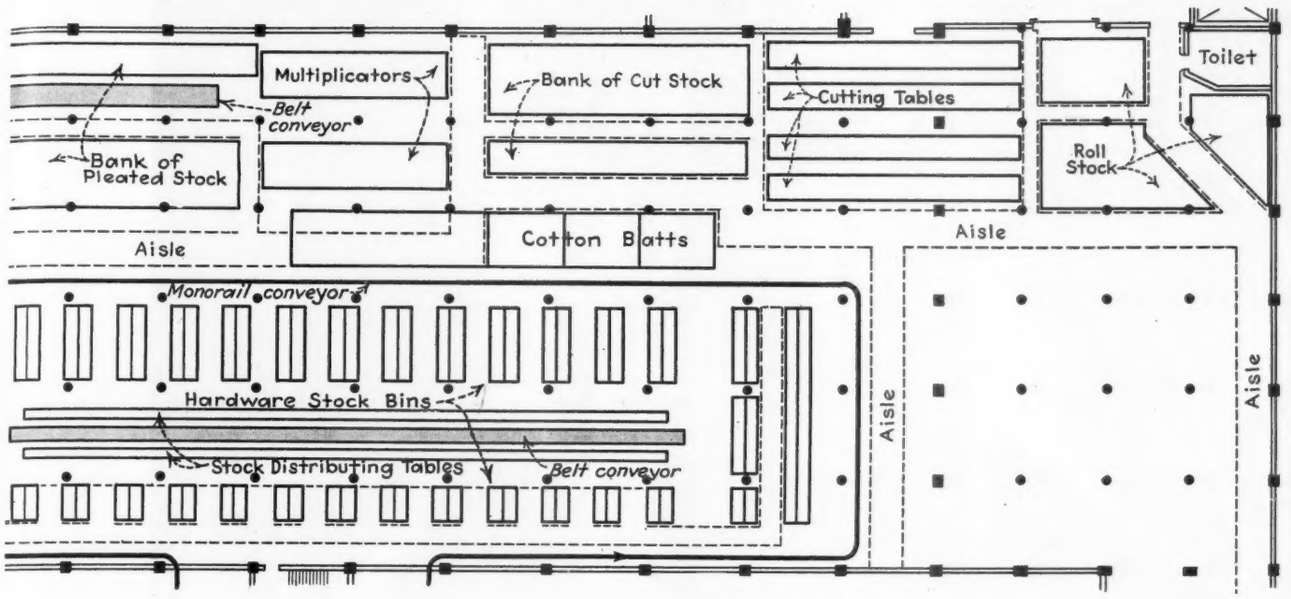
One is a new unit, and when it was installed alongside the north wall its partner was moved over from the middle of the floor. In the old arrangement, subgroups were placed around the multipleater and a great deal of backtracking was involved. In the new layout there is a straight flow of material from the cloth stock rolls at the east end to the sorting area at the west end of the plant.

Beginning with the cloth rolls, the stock progresses to long cutting tables, where it is sheared electrically, then stacked prior to pleating. Alongside is another bank of cotton batts which are brought up from the receiving dock by a large bucket conveyor. Almost as large a bank of pleated sections is required on the other side of the machines. These sections are then laid out on a 5-ft. belt conveyor and sheared electrically into individual seat pads.

80 Sewing Machines, 30 New

West of this line is a battery of 80 sewing machines, placed in two equal rows back to back with a belt

Hardware kits for K-D shipment are delivered by belt to this point for shipment via the cross belt in the middle of the room



conveyor in between. This layout is new, and 30 machines have been added this year to meet the new production requirements. Side by side the machines and work tables occupy a space 180 feet long. Work is drawn from the banks of pleated stock and the first group of cutting tables. Finished pieces are thrown on the belt conveyor and brought to inspectors.

Leaving the inspection tables at the end of the conveyor, the assemblies go to sorting and mating stations. Textiles not fabricated in this room come up in the overhead bucket conveyor mentioned above and are transferred to a belt conveyor in the middle of the room, then by truck to convenient stock piles.

From sorted piles, sets can be made up for complete bodies, either for knock-down (K-D) shipment or built-up jobs. After being inspected, K-D sets are packed in cartons and sent toward the middle of the room on a belt conveyor. Transfer takes place to a cross belt conveyor going to another building and eventually discharging to the shipping dock via a spiral chute.

How Hardware Is Handled

This same conveyor carries cartons of hardware sorted and packed in the southeast bay of the room. All body hardware is purchased material, and this section serves as a combined shipping and receiving department.

Incoming material is sent up from the receiving dock in the bucket conveyor that loops this section. Parts are checked and segregated in steel bins on either side of a pair of long distributing tables with a belt conveyor in between. For convenience in finding stock, each row of bins has as its end a panel board to which a sample of every part in that section is stapled. This kind of identification is much more intelligible than a blueprint or a list of part numbers.

[A final article on the new Murray Manufacturing set-up is scheduled for early publication.—Ed.]

Public Employment Offices

THE SUCCESSFUL administration of any plan for nation-wide unemployment compensation will be largely contingent upon the establishment of a competent service that will bring together employers in search of able workers and qualified persons seeking jobs.

It is therefore of interest to record that the New York State Employment Service, with 6 offices in the metropolitan area and 7 upstate, has been supplemented by 50 National Reemployment Service offices in rural and urban communities. This National Reemployment Service has been set up by the U. S. Employment Services for states that have no such service of their own and to supplement existing state services.

Everyone Saves

Through this service both workers and employers are saved time, energy, and expense. Workers need not waste their dollars and their courage in fruitless travel. Employers are saved interviewing hundreds of applicants of whom few, if any, may be suited to the work they have.

The public employment service undertakes the task of selection. Applicants for work are registered, interviewed privately by placement experts familiar with employers' requirements. Records, aptitudes, and skills are thoroughly examined, applicants classified. The service studies seasonal fluctuations within the chief industries of the state and classifies the jobs within those industries, in order more intelligently to meet placement problems.

Through a state-wide system of job clearance the public employment service is enabled to draw upon the resources of all offices in the state when an employer's job requirements cannot be met from among the available workers in his own community.

Rittase photograph. Cabinet in glue press at Philco gets some of the hand touch that distinguishes a quality product

Every five years one-seventh of our skilled workers reach retirement age. During the five years just past, many plants discontinued their training plans. Where, in the next five years, will industry find skilled replacements? This is no time to think of a shorter work week that will intensify existing and impending shortages of skilled labor

No Big Trend to Daywork

Say nine of ten commentators on "It's Hour Rates in Detroit" (January, page 9). For earlier discussion, see February, page 66

Piecework a Misnomer, but OK

CROSBY FIELD
President, Brillo Manufacturing Company, Brooklyn

THE reported trend of the automotive industry to abandon group bonus and piece rates in favor of straight hourly rates has not yet produced a noticeable trend in the limited number of industries with which the writer is acquainted. The superficial differences between the two types of industry may be summarized as follows:

	Automotive	Limited Group Observed
Predominating sex of worker	Male	Female
Degree of skill	High	Unskilled
Organized labor	Yes	No
Variation in daily opportunity to work over past four years	High	Negligible
Conveyor or equivalent	Yes	Yes — In Part
Does conveyor or equivalent entirely determine output?	Yes	No
Concentration of supervision	High	Low
Variety of product	Small	Large
Ratio labor cost to finished price	High	Low
Frequency of change of worker from job to job	Low	High
Size of plant	Large	Small
Contact of executives with labor	?	Very close

The question, "Does conveyor or equivalent entirely determine output?" is meant to indicate a flow difference. An automobile at the end of the conveyor is either finished or not. In the other case the raw material travels down the conveyor to eventual waste; the operators take off as much to fabricate for finished product as their abilities permit.

In considering the retention of the group bonus and/or piecework in the limited group, the following peculiarities of the relation between method of pay and operation should be mentioned:

1. Those whose duties consist entirely of keeping the conveyor (or its equivalent) running, and properly fed with its raw materials, or whose work involves inspection, are on a straight hour rate.

2. The entire force concerned with a change in machine or operation are taken off the bonus or piecework system and placed on an hourly rate until the new operation or method has been thoroughly installed and standards have been set.

3. Short interruptions to production due to mechanical breakdown automatically shift the piece and bonus workers to time work for the duration.

4. Those on piece and bonus work are only those whose production is specifically measured by individual effort.

5. Group bonus and group piecework are the most usual, but the number of workers in a group is kept to a minimum, never more than six, and normally only three or four.

The principal difficulty with piecework has been that it is a misnomer; it is based upon an estimate of fair daily wage, and cannot be maintained indefinitely at a rate determined to be fair at the time and under the conditions of the industry when set.

Other Industries Won't Follow

In time of great change, either in operation or in industrial conditions, the only safe method of pay which can be justified is that based upon time alone. In an industry not confronted by threats of internal change, other systems which have proved satisfactory in the past may be continued safely. Based on this premise it is believed the reported change in the automotive industries will not be extended to more than a limited group of industries, and for a limited time.

People Like Piecework

JAMES W. HOOK
President, The Geometric Tool Company, New Haven, Conn.

I WAS surprised to learn from the article entitled "It's Hour Rates in Detroit" in your January issue that piecework and other wage incentive plans are on the way out in the automobile industry. I am not convinced that the movement is typical of all industry.

In our own case I believe the elimination of piecework would be seriously objected to by the workers. The men like it because it gives them a chance to earn above a definite day rate base, which we maintain, on the strength of individual merit. This is particularly true of the more skilled workers.

Of course, when orders are scarce and production is frequently interrupted by lack of a continuous flow of orders, it is possible that piecework may lose some of its advantages. During such times the substitution of an hourly wage plan would probably not be difficult. But when business is brisk and in plants where piecework rates had not been changed except for the best of causes, I doubt if a switch to definite hourly rates would be accepted without protest.

Employment conditions have been materially altered as a result of curtailed operations and shortened hours under NIRA codes. The average worker understands the situation as well as the employer. He knows that a plant without orders cannot provide jobs. He knows, too, that such work as exists should,

within reason, be distributed among as many workers as possible. During such periods about all he expects is enough wage to live on. Whether it comes to him by way of piecework or hourly wages is not important.

When work is plentiful, however, the better class of workers—if not, indeed, all workers—want the opportunity to earn more, and in my opinion, they should be given that opportunity.

As the article pointed out, piecework in large measure provides its own supervision. A man is paid for what he accomplishes, not for what a foreman thinks he should accomplish. The difference is vastly important in its effect upon employer-employee relationships. Only where piecework or bonus rates are changed for selfish and unjustifiable reasons, or set at unreasonable levels, can the practice carry the same implications of arbitrary supervision that are contained in the practice of paying straight hourly wages.

I have never been strong for group bonus plans. Too often they penalize the more highly skilled workers by averaging their accomplishments with the accomplishments of those who are less skilled.

The Consumer Is the Real Boss

WINTHROP L. CARTER
President, Nashua Gummed & Coated Paper Company
Nashua, N. H.

SYSTEMS of wage payment have always been controversial subjects between employers and labor. Measured tasks determined by time study undoubtedly raised labor's efficiency tremendously.

When the measurements were fairly and accurately made, labor's earnings were increased, costs reduced, with resulting advantage to the consumer. But when rates were carelessly and harshly set, gross abuses soon developed under the cutthroat competition of the past few years, poor methods and managerial delays caused low and fluctuating earnings—all as pointed out by the automobile men.

Labor has declared war on these mistakes. Thoughtful employers are equally concerned but believe more lasting progress can be made by cooperation than by strife.

A simple change from piece rate to hourly wage is too superficial to be a permanent solution.

As the NRA wears on, both management and labor are finding gains are losses unless the consumer's interest is adequately protected. Price fixing and production restriction, for example, are going out.

In a nutshell, hourly rates demand greater efficiency on management's part—piece rates, on labor's part—in the control of costs. The automotive men point out they expect increased managerial efficiency to offset any possible loss in efficiency by labor. This is not a problem of simply satisfying management or labor; the real boss of the situation is the consumer. Without him there is no production or wages to argue about. He should have the benefit of all possible efficiencies.

As to whether his interests are best served by piece rates, hourly wages, or a combination of both methods rests mainly in the type of production. The important point is to approach the problem on a basis of cooperation in the interests of labor, employer, and consumer.

Weekly Pay Is on the Way

RALPH F. COHN
Factory Manager, Reynolds Wire Company, Dixon, Ill.

HOURLY rates are the rates of the *hour*—of the hour of transition from the complicated piece rate methods of more active times to the more socially-minded weekly pay plans of the immediate future. Among the causes for this change might be mentioned the following:

1. *Governmental policies*—Present codes have expressed minimums in terms of cents per *hour* and maximum work weeks in terms of *hours*. New employment insurance legislation refers to minimum wages per *week* and minimum working *weeks* per year.

2. *Idle machines*—No need of a piece rate as an incentive to produce a maximum output per day. A lower output per day means fewer idle days but not lower fixed charges per unit of production. Possibility of forced intermittent operations discourages the use of costly automatic machinery with its high annual fixed charges and necessity for skilled operators. Better buy a simpler, cheaper, less automatic machine with lower fixed charges per unit and hire semi-skilled labor abundantly available at the minimum *hourly* rate.

3. *Smaller production orders*—The customer must be pleased, so the regular product gives way to a wide variety of modifications; half of the piece rates in the place are scrapped in favor of a fair hourly rate. No one modification seems to be produced steadily enough to justify a new rate determination.

4. *Fewer new skilled employees*—Old-timers know just about how much or how little constitutes a day's work. Whether measured in output or in time, a day's work is worth a definite amount. Only the new hands who cannot produce so much need the piece rate to measure earnings.

5. *Nature of the equipment*—Many jobs limit the performance of a worker to that of an attendant. Codes place a limit on the hours per week. A weekly pay check (often at the minimum code rate) is the simplest method of payment that has so far been developed.

6. *Supervision has improved*—Increased use of machinery has decreased the number of man-hours per unit without decreasing the supervision required per unit. The proportion of "white checks" on pay day has increased, emphasizing the trend toward the weekly basis.

7. *Codes permit greater freedom to salaried workers*—A man earning 80c. per hour works 40 hours per week and earns $32. If he works 50 hours, it costs his employer $1.20 an hour for the additional 10 hours, or a total of $44. If the worker is put on the salary roll as an assistant foreman at $40 a week, the employer

(Continued on advertising page 50)

An Okay on Research

Kayos the stupid price-cutter. This concern writes results in terms of better quality, lower costs, increased sales, bigger profits

CHARLES P. BARKER
Chief Engineer, Container Corporation of America
Chicago

RESEARCH first interested us as a possible answer to unintelligent price competition, which in paper and corrugated packing boxes had been carried to a point where some of the products offered as boxes were hardly more than bags. Nobody profits from that sort of competition. Our company sought a way out.

A new sales approach was called for. But it was not enough to stress quality. Boxes are sold to buyers who cannot afford to spend a cent more for a box than is needed to deliver the goods safely.

The selling problem thus turned out to be a manufacturing problem. When it was put up to production men who had spent their lives in the business, the answer was, to make better boxes one had to use more costly "furnish"—paper and pulp stock.

But higher quality with higher cost was no answer in this case. Greater values had to be obtained out of existing materials and resources. We decided to see what possibilities a research organization could develop. A department was therefore organized, a program agreed upon. Engineers and research workers were recruited from the universities and the industry.

What Is a Good Box?

The first step in the new program was to find out what constituted a good box and at what points box failures most commonly occurred. The study upset some hitherto unquestioned beliefs. For example, the Mullen test had for years been the standard by which to judge box stock. The sample of paperboard is burst by hydraulic pressure applied through an elastic membrane. The test is useful in indicating toughness and resistance to puncture, but it was found that puncture was not usually the point of failure for packing boxes.

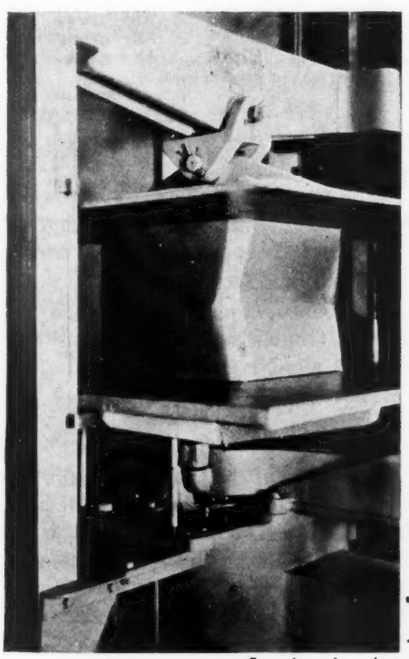
Meeting Compression Tests

The critical quality was the ability of the box to stand up under a compression load. Heavy boxes were piled six or eight deep in a car, imposing a crushing weight on the bottom tier. The boxes are subjected to equally severe loadings by a jolt of car or truck. Such conditions are duplicated in essence by a test which puts a box, made up as for use, under a gradually increasing compression load until it fails.

Manner of failure in the compression test tells much. In one sample, the sidewalls will buckle along a more or less straight line. Back to the corrugating department goes word that the glue rolls are not spreading uniformly and have left a dry strip on the liner stock and a weak point in the box. Or a box buckles at the edges, indicating perhaps that the stock is not stiff enough, perhaps that it was scored too deeply for folding, or not enough. Perhaps the tape that seals the joints has not been properly applied.

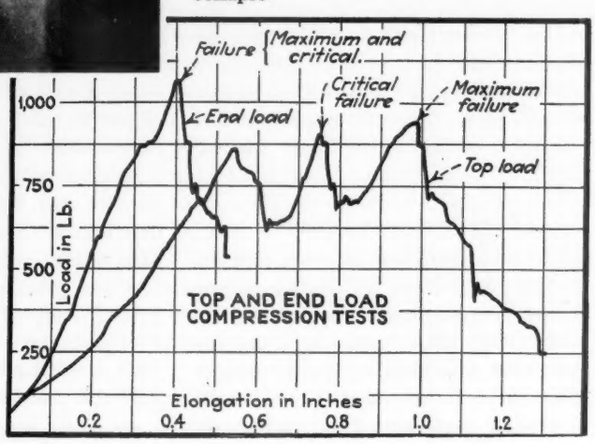
Box failure often started along the lines of printed matter. The letterpress imprint had scored the surface and left a weak point. A special printing process remedied that trouble.

As fast as possibilities for improvement were found, investigation



What constitutes a good box? Where do failures commonly occur? Compression tests supply the answers. For example, the box in the photograph is being tested under end loading and has failed at 1075 pounds (see chart) through collapse of side walls at a line between the meeting of the inside flaps

Another random sample (again see chart), when tested under top load, failed at a point well above the standard specification. Note how the load was taken up by the side walls as the edges failed, indicating equal strength of all parts of the box and providing protection after the initial point of collapse



reached back into the factory to incorporate them. Once the right method or specification was found, it was maintained and controlled by instructions, process changes, and routine testing.

Process Control

For example, one of the qualities which paper makers distinguish in pulp is "freeness," a quality dependent on the gelatinous content of the fiber. If this content is too high, the resultant paper is tough but lacks stiffness; if too low, the paper is stiff but brittle. When the degree of freeness which gave the best combination of these two factors was found, it became possible to control the processing of each batch of pulp and stock, and thus secure the particular degree of freeness most suitable for liner, filler, or any other variety of box board stock.

Once the basic specifications were established, the research laboratory gradually assumed the function of routine process control, while continuing its experimental work.

The laboratory is air-conditioned to secure uniform results, winter and summer, and stock is carefully brought to a uniform moisture content before testing.

Tests are of three general styles. All raw materials are tested on receipt. Samples are taken every forty minutes at key points in processing and tested. Eight times a day, finished samples are picked at random from orders going through the shop and given the full routine of tests.

A Uniform Product

Any deviation from standard can at once be found and corrected. The tests prevent bad workmanship from reaching the customer, and stop further spoilage. They also serve to keep the operating organization on its toes, at the same time helping it to solve its problems as they arise.

Uniformity has become so much a matter of course that the company now sells its boxes under definite performance guarantees. In many cases synopses of the tests are forwarded through the sales manager to the customer for representative lots of boxes sent him. The control laboratory has become the "supreme court" of the factory.

How did operating men take to the findings of these newcomers, some of them young engineers with the ink hardly more than dry on their diplomas? Much misunderstanding might have been created had the matter been handled without an appreciation of their point of view.

The first step taken, before any attempt was made to establish a routine, was to find the facts. This procedure was followed both in the initial investigations and later in establishing a control laboratory and installing a technical director in each plant. The figure shows the standard organization plan for all plants.

Plant Men Take Initiative

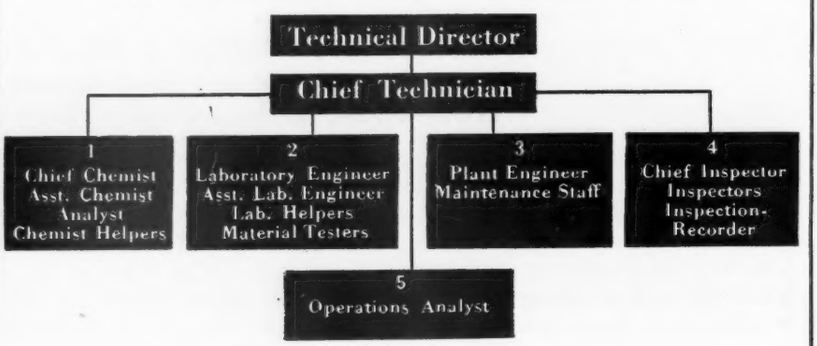
The new technical director and his staff did not start by giving orders or interfering with routine. They went about their business of asking questions and making tests, gradually getting acquainted with the operating men and their problems. They were available for consultation should trouble arise; in general they let the plant men take the initiative in asking for such aid.

Even a Technician May Be Wrong

Members of the technical staff were told that they were on trial and could not afford to be wrong. Once in a while they were, of course, and the chief engineer had to straighten things out. But often they were able to find and remedy the trouble, as when a roll of stock refused to run off with an even tension in the corrugator, and a brief investigation showed that the roll had stood on one end until the other end had dried and shrunk. The application of a steam jet to the dry end often brought peace to the corrugating room. When the answer was not forthcoming at once, the technical man went back to his laboratory to find out the reason why.

(Continued on advertising page 62)

Typical Plant Control Organization



Responsibilities of Groups

Raw Material Control
- Coal, paper stock, pulp, chemicals, silicates, glues ..... Group 1
- Outside roll stock, wrapping paper, twine, tape, inks ..... Group 2

Mill Control
- Materials handling ..... Group 5
- "Furnish," stock refinement, shrinkage and waste, stock waste, mill sheet inspection and records at chart room ..... Group 1

Box Plant Control
- Quality, tie-up, production, inspection, waste control ..... Group 4
- Routing ..... Group 5
- Printing plates, box laboratory ..... Group 3

General
- Special determination ..... Any group
- Testing services to head office ..... Any group
- Special tests for sales department ..... Any group
- Education—on quality and compression for sales, production, etc. ..... All groups

Process Improvement ..... Group 5
Plant Betterment ..... All groups
Maintenance and Mechanical Problems ..... Group 3

"I hereby give and bequeath—"

Said John J. Eagan 10 years ago. Since then American Cast Iron Pipe employees have shared $3,600,000 of company profits

C. D. BARR
Vice-President, American Cast Iron Pipe Company
Birmingham

JOHN J. EAGAN had the traditional rich uncle. At the age of 29 he inherited a considerable fortune. It grew under his hands during the next 25 years—and with it, an increasing sense of the responsibilities that go with wealth. Ten years ago he died, leaving a will that many thought could not work.

His Will

Eagan's will made employees of the American Cast Iron Pipe Company beneficiaries of the entire common stock of the company. All earnings on the stock were to go to them in cash or be expended for preservation and upbuilding of the company, or for facilities and services for their use and benefit. Since 1924 somewhat over $3,600,000 has been thus expended. At present, profits permit of paying each employee up to 25 cents a day, four days a week, in addition to his regular wage. Payments one year ran as high as $1 per day.

This cash distribution is not made until adequate provision has been set aside for necessary operating reserves. The benefit is paid separately, so that it will be recognized by the employee as such. It is a real benefit, for, independently of this payment, the company pays the highest going wages in the district for common labor. An employee becomes the beneficiary of the will when he enters service and remains so during his employment.

The common stock of the company is placed in the hands of trustees, in two groups representing management and labor. One of these groups, called the Board of Operatives, is elected by the workers, voting by geographical or shop districts. This board is composed of twelve men, six elected every year for two-year terms. The Board of Managers is appointed by the Board of Directors and consists of five men active in and responsible for the operation of the business. Joint meetings of the two boards are held periodically. These trustees elect the Board of Directors, which has final decision in any disagreement between the two boards.

The fact that the subject of this posthumous experiment in human nature has grown and prospered, does not imply that all concerns should go and do likewise. But it may shed a few sidelights on the elusive problem of industrial relations

An effort is made to plan work so that regular employees can work not less than four days a week throughout the year. This is felt to be the most practical way of meeting the stipulation of protection from unemployment made in the will.

Depression Experiences

The depression put the company's policies to a severe test. There was work for only a little over half the regular force. The rest had to be laid off. When the management decided that, say, 100 men must be laid off, the supervisors selected those who could best be spared and notified them. They were not thrown out without further attention, however. They were put on half time and pay until the committee on living conditions of the Board of Operatives could consider their cases.

About 55 per cent of the normal force of 1,000 employees are negroes. Most of these negroes came from the farm. Joe, a colored man with a wife and 2 children, might owe $40 in small debts around town. "Setting him on his feet" might involve paying these debts, moving him, his family, and his household goods to an uncle's farm where there was room for him until the depression was over, buying him a mule, and allowing him $15 a month for six months until he could make a crop. In another case, a man might think he could make a go of a barbecue stand or a shoe repair shop, and the money would be furnished to start it. Each according to his circumstance, every man laid off was thus given a fresh start.

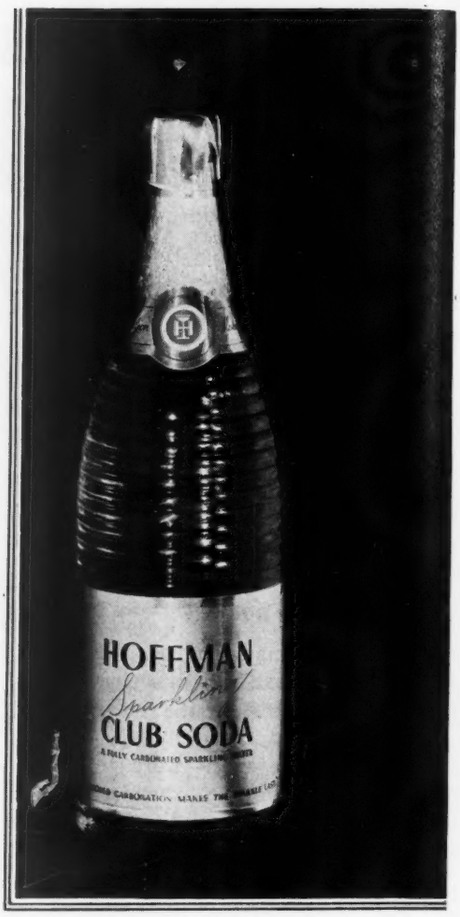
One of the perennial troubles with all large forces is the question of garnishments and assignments. Eagan's will set aside a revolving fund of $15,000 for emergency loans to employees, without interest for the first two months. In 1928 an active campaign of education against improvidence was started. "Only improvident people buy luxuries beyond their means and get in the hands of the loan shark." In 1928 there were 749 cases of garnishment and assignment. In 1929 this number dropped to 711, then to 437, 254, 158, 36, finally 15.

So Far It Has Worked

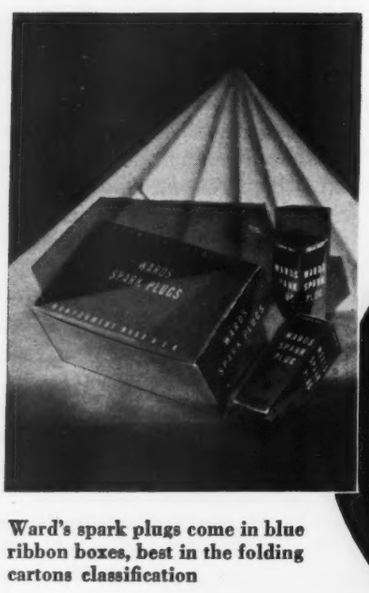
Whether the organization devised by John Eagan will continue to function smoothly no one can foretell. So far, after more than 10 years of test, it has worked. Its members have carried to completion and patented important technical developments in centrifugal casting of pipe. The company has weathered the depression and is making money. And in a very quiet and unobtrusive way, one senses in the organization a mutual loyalty and confidence that seem amply to have justified this experiment in human nature.

PICK OF THE PACKAGES

More than 400 packages competed for the Wolf Award "for the best package developed and placed on the market during 1934," held in connection with the American Management Association's Fifth Packaging Exposition, Chicago, March 5-8. These six won blue ribbons in their respective classes



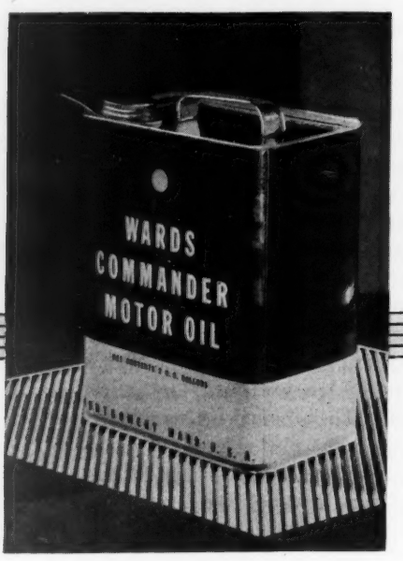
A toast—make ours Sparkling Club Soda—to the best glass container and winner of the Wolf Award

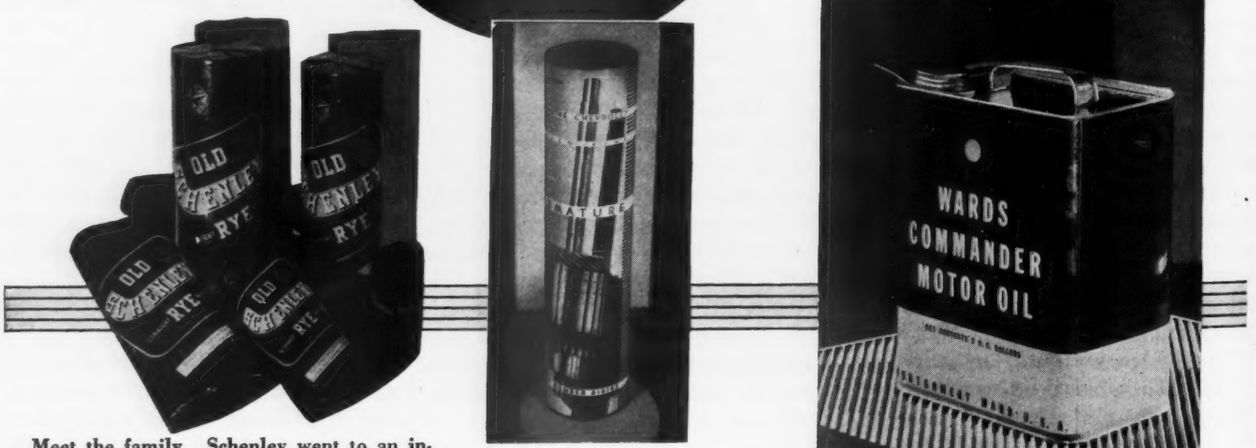


Ward's spark plugs come in blue ribbon boxes, best in the folding cartons classification

If you eat more cranberries in 1935, blame it on General Box Company's display crate. Best in the wood containers class

Best of the tin containers is Montgomery Ward's oil can, whose handy snout helps you pour





Meet the family. Schenley went to an industrial designer, got this prize-winning "family of packages" . . . Best canister is this fiber one for armatures

And When You Fire Me

"Quit foolin' around and tell the truth," says Joe, who skates a figure 8 on thin ice as he gives the Big Boss the lowdown

CHARLES S. STEVENSON
General Manager, Hall Brothers, Inc.
Kansas City, Mo.

"JOE, how would you like to be fired?"

"Well, uh . . . . that is . . . . now—just what do you mean? What's happened?" I fumbled.

"Well, I've just let young Harris go. Tried to tell him why, but he wouldn't listen. Got sore and told me where to get off. Honestly, I never know how to let people out. I just thought if you had any ideas I might try them."

It was my boss talking.

"Well, when you come to fire *me*—just slip me the straight truth!"

I startled him, so quickly did I answer.

"This idea you fellows have of beating around the bush with 'things are beginning to look bad!' 'work running out!' and all that stuff is bunk," I continued. "Isn't it generally because we are just not making good?"

"In a measure. For three years now, though, we have had to release a lot of capable folk. No work."

"That's true, but you do have to decide between some and the others, don't you?" I pressed him.

Tell Them the Truth

"Of course," he answered spiritedly. "There's that fine, almost indefinable, shading that causes you to decide whom to release and whom to keep. Honestly, the people I fire worry me more than the ones I keep."

"You're too conscientious—yet you've the right idea. Here's where I think you make your mistake. You try to pacify the fellow you let go. You don't have the courage to tell him he is slow, inaccurate, indifferent, or what, so you just ease him out by the line of least resistance."

"Nobody likes to have you tell him what's wrong with him!" he answered. "For what few appreciate it there are a hundred who storm

. . . I came by to thank you for discharging me

around and make you feel as if you were burying their entire family alive."

"Well, whether we admit it or not, we want to know the real reason for our discharge. Frequently one of the best things that can happen to a fellow is to get fired!"

They Won't Like It—But

"Deep down in my heart I know you're right, Joe," the boss answered seriously. "I realize that the manner in which I discharge a person, the way I talk to him, the words I use, the reasons I give, are of great concern to him."

"And that remark right there reminds me of a story a former boss of mine used to tell and one which may give you a little different slant on the problem.

"Raymond Barker was a stock lister, a fine boy, reasonably accurate, easy to get along with, and of average capacity. But he couldn't get the big idea—couldn't, for example, figure out why the work he did must be finished by noon Wednesday to fit in with similar reports from Los Angeles and Chicago. But sadder than all that was his blissful ignorance of his weakness. He was stunned when told of his discharge. Well, Old Man Bradford told him exactly why he was being let out.

"'I knew you wouldn't like what I had to say,' were Bradford's final words, 'and you'll think I'm trying to be sarcastic when I tell you I'm doing you a favor.' A year later I was sitting at Bradford's desk when along came Ray.

They'll Probably Thank You Later

"'Mr. Bradford,' he said, 'I came by to thank you for discharging me last March. It was the best thing that ever happened to me and I consider it a real favor. It woke me up—got me out of my rut—jarred me into action. Monday I leave to be assistant manager of the Bracken Company's Chicago branch.' Bradford didn't know whether he was being kidded or not, but Ray convinced him he was sincere. Well, sir, to this date Mr. Bradford invariably spends more time discharging his employees than he does hiring them.

"When you discharge us, give us the exact reason, no flowers or sad music. We may not like you *then* for it, but deep down in our hearts we are probably agreeing with you and figuring out every possible way to show you up and prove that you were making the mistake of your life in letting us go. In other words, you are acting as a *challenge* to us. A couple of years later we'll be bragging around about how much good 'old so-and-so' did us when he fired us."

"Where do I come in on all that?" queried the boss.

Just in the satisfaction of helping others, and to sort of ease off that old conscience of yours—just in case you might be wrong—which you will be if you ever let *me* go!"

And with that I beat it.

Next Month—
How I Want My Boss to Be

Forecasting the Profits

Last of three articles outlining the essentials of "profit control budgeting," a technique that helps plan and get better sales, bigger profits

C. E. KNOEPPEL*
The Knoeppel Company, Philadelphia

IT IS logical to conclude that, if we are in possession of quantitative data about the fundamental trends of a business and can definitely relate and appraise these trends, we are then in a position to forecast probable results, against which to compare actual performance later on.

In other words, if we know the fixed and variable characteristics of costs by products, and the effects of these characteristics on profit and loss as proportions of monthly sales volumes change, then we can budget cost of sales for given sales income and forecast the profits.

Principle of Variation

Before we go further in describing the procedure, however, we must give some thought to an important principle that exerts a vital influence on what we are attempting to develop and present.

The Profitgraph is a "graphic variable profit and loss statement." It pictures the fixed and variable costs in relation to sales volume, expressed in both dollars and per cent of capacity. It indicates sales income and cost of manufacturing those sales, as well as commercial and financial costs that are charged to them.

Fixed costs in dollars being the same from zero sales capacity to full sales possibility, it follows that they increase or decrease "per unit of output" or "per dollar of sales" as sales volume decreases or increases. Consequently the question, "What is cost?" cannot be answered as stated, because fixed costs on a unit basis form a hyperbolic curve, hence total cost is a curve and is different at each point of sales capacity.

It is necessary, therefore, to deal with these fixed costs in terms of some common denominator by "pegging" them at a normal or average sales capacity point, in order that we may predetermine costs, observe the effect of variations due to rise and fall in volume, and furnish the basis for economic pricing.

Another factor enters into our consideration. We rarely manufacture and sell at the same capacity point during a given time. Many concerns produce much and sell little in some months, and reverse the process in others. In the one case we add to inventory; in the other we decrease this inventory. Both movements exercise an influence on costs.

Figure 1 illustrates what is meant. It indicates the degree of "under-absorption" and "over-absorption" of these fixed costs below and above the normal or average sales capacity point (for commercial and financial costs as well as costs of manufacture), and their relation to manufacturing and selling at different capacity points at different times.

Basis of Variable Budgeting

Let us assume that we are dealing with a situation with three products, with respective fixed and variable characteristics as shown in the first two columns of Table I, along with rates at normal capacity in the third column found by dividing the sum of fixed and variable costs at this point by the normal sales. From this sheet, we get the monthly standards at normal capacity shown in Table II.

Either as soon as we can predetermine the sales and production (at the equivalent sales prices at list) for any one month, or when actual figures are available after the first of any month covering sales and production, we can start the work of budgeting and forecasting. See Table II for these budgeted or actual figures.

It will be seen from these figures that our normal sales are at one point, our actual sales at another,

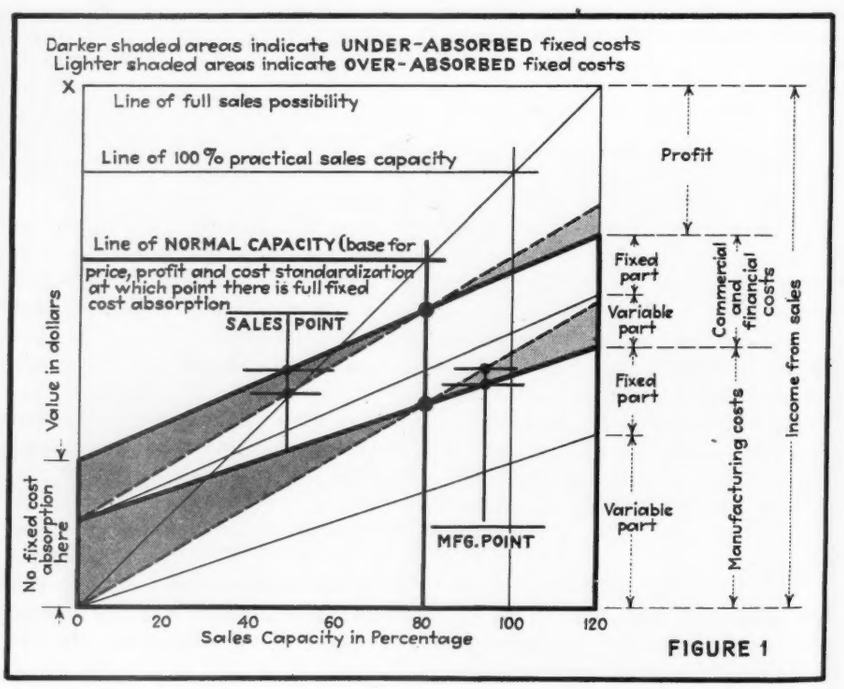


FIGURE 1

*With Edgar G. Seybold collaborating.

Table I. Budgeting Standards

Product A $90,000 — 30% Normal sales $72,000

Items	Fixed in $	Variable in %	Standard % at normal	
Material	.....	18%	18.00%	....
Labor	.....	15	15.00	....
Mfg. expense	$5,400	7	14.50	47.50
Administrative	3,600	2	7.00	....
Selling	6,300	6	14.75	21.75
Financial	900	2	3.25	3.25
Cost	$16,200	50%	72.50	72.50
Profit			27.50	
Sales			100.00%	

Product B $150,000 — 50% Normal sales $120,000

Items	Fixed in $	Variable in %	Standard % at normal	
Material	.....	22%	22.00%	....
Labor	.....	14	14.00	....
Mfg. expense	$9,000	6	13.50	49.50
Administrative	7,500	5	11.25	....
Selling	4,500	11	14.75	26.00
Financial	3,000	2	4.50	4.50
Cost	$24,000	60%	80.00	80.00
Profit			20.00	
Sales			100.00%	

Product C $60,000 — 20% Normal sales $48,000

Items	Fixed in $	Variable in %	Standard % at normal	
Material	.....	35%	35.00%	....
Labor	.....	10	10.00	....
Mfg. expense	$4,800	7	17.00	62.00
Administrative	3,000	5	11.25	.....
Selling	3,600	11	18.50	29.75
Financial	1,800	2	5.75	5.75
Cost	$13,200	70%	97.50	97.50
Profit			2.50	
Sales			100.00%	

Combined A, B, C $300,000 — 100% Normal sales $240,000

Items	Fixed in $	Variable in %	Standard % at normal	
Material	.....	23.4%	23.40%	....
Labor	.....	13.5	13.50	....
Mfg. expense	$19,200	6.5	14.50	51.40
Administrative	14,100	4.1	9.98	....
Selling	14,400	9.5	15.50	25.48
Financial	5,700	2.0	4.37	4.37
Cost	$53,400	59.0	81.25	81.25
Profit			18.75	
Sales			100.00%	

and our actual production at still another. We must therefore develop both the costs at "normal" capacity and the "allowed" costs at the actual use of capacity for sales and manufacture at their respective capacity points.

The difference between normal and allowed costs will automatically give us the relative over-absorption and under-absorption of our fixed costs, or "variations due to volume," which, generally speaking, are uncontrollable variations.

Later on in the month when the profit and loss statement is compiled, the comparison of "actual" costs against "allowed" costs will give us the variations due to rise and fall in costs, which, generally speaking, are controllable variations.

The Profit Forecast

We are now ready to make the calculations entering into the forecast of profit. Owing to lack of space we will illustrate the method by two examples. Again refer to Table II.

Carrying out this procedure for the rest of the items we have the elements which are shown in the *A* section of Table III. I believe it will be found self-explanatory.

The *B* section of this record is compiled after the profit and loss statement is available and comparisons are made with the "allowed" costs.

This kind of statement can be made for any current month and for the year to date.

Two outstanding points will be observed. First, there was a reduction in standard profit from $45,000 to $32,375 due to lowering the proportion of sales of products *A* and *B* which had the larger profits in them, and raising the *C* proportion

Table II

Monthly Standards at Normal Capacity

Product	Proportion	Sales	% profit	Amt. profit
A	30%	$72,000	27.50	$19,800
B	50	120,000	20.00	24,000
C	20	48,000	2.50	1,200
Total	100%	$240,000	18.75	$45,000

Budgeted or Actual Figures

Product	Sales	%	Production	Inventory change	Inv. change @ std. mfg. cost	Profit @ std. rate
A	$50,000	25%	$140,000	+$90,000	+$42,750	$13,750
B	85,000	42½	50,000	— 35,000	— 17,325	17,000
C	65,000	32½	110,000	+ 45,000	+ 27,900	1,625
Total	$200,000	100%	$300,000	$100,000	+$53,325	$32,375

Manufacturing Expense

Item	Standard	Allowed	Variation
$140,000 production	X 14.50% — $20,300	X 7.0% — $9,800	
50,000 "	X 13.50% — 6,750	X 6.0 — 3,000	
110,000 "	X 17.00 — 18,700	X 7.0 — 7,700	
		"F" — 19,200	
$300,000	$45,750	$39,700	+$6,050
Selling Expense			
$50,000 sales	X 14.75% — $7,375	X 6.0% — $3,000	
85,000 "	X 14.75% — 12,537½	X 11.0 — 9,350	
65,000 "	X 18.50 — 12,025	X 11.0 — 7,150	
		"F" — 14,400	
$200,000	$31,937½	$33,900	—$1,962½

Table III. Forecast of Profit and Comparison with Actual

Items	A: Standard costs at normal capacity	A: Allowed costs at actual use of capacity	A: Volume variations allowed over standard	B: Actual costs from P & L statement	B: Cost variations actual over allowed
SALES	$200,000	$200,000	.....	$200,000	
Material (Incurred at $300,000 of production)	74,700	74,700	.....	81,200	—$4,500* / — 2,000†
Labor (Incurred at $300,000 of production)	39,000	39,000	.....	40,500	— 1,500
Mfg. expense (Incurred at $300,000 of production)	45,750	39,700	+$6,050	39,000	+ 700
Total	159,450	153,400	+ 6,050	160,700	— 7,300
Subtract for *increase* or add for *decrease* in inventory	53,325	53,325	.....	54,125	+ 800
MANUFACTURING COST OF SALES	106,125	100,075	.....	106,575	— 6,500
Gross profit margin	93,875	99,925	.....	93,425	.....
Administrative cost	20,375	22,600	— 2,225	23,900	— 1,300
Selling expense	31,937.50	33,900	— 1,962.50	35,800	— 1,900
Commercial cost of sales	52,312.50	56,500	— 4,187.50	59,700	— 3,200
Operating profit	41,562.50	43,425	+ 1,862.50	33,725	— 9,700
Financial cost	9,187.50	9,700	— 512.50	9,000	+ 700
NET PROFIT ON "COST OF SALES" BASIS	$32,375	33,725	+$1,350	24,725	—$9,000
Estimated minus cost variation @ 3% of sales		6,000	Profit forecast	27,725	
FORECASTED "ALLOWED" PROFIT		$27,725	Error in forecast	$3000—1½%	

Standard profit	$32,375	Allowed profit	$33,725
Plus over-absorbed	6,050	Plus variations	2,200
Total	38,425	Total	35,925
Minus under-absorbed	4,700	Minus variations	11,200
Allowed profit	33,725	Actual profit	24,725
Less added to inventory	53,325	Less added to inventory	54,125
Profit "incurred" basis	—$19,600‡	Profit "incurred" basis	—$29,400‡

— RECONCILIATION —

Standard profit			$32,375
Variations			
Mfg. volume profit	.....	$6,050	
Sales volume loss	$4,700	.....	
Purchasing loss	4,500	.....	
Inventory adj. profit	.....	800	
Cost variation loss	5,300	.....	
Totals	$14,500	$6,850	
Net losses due to variations			$7,650
ACTUAL PROFIT AS PER P & L STATEMENT			$24,725

*Loss due to purchasing.
†Loss due to faulty utilization of materials.
‡"Incurred" basis means deducting commercial and financial costs incurred plus incurred costs to manufacture the stated production for the month from the sales of that month.

in which there was only a slight profit. Second, the standard profit was reduced from $32,375 to $24,725 because of an excess of minus cost variations.

It will be seen upon examination that the statement is indeed comprehensive, showing profit and loss on both an "incurred" and "cost of sales" basis, as well as indicating variations due to manufacturing and sales volume, purchasing, cost, and inventory fluctuations. In addition, it is based on the principle of variable budgeting.

Conclusion

In the first of these three articles we dealt with the fundamental characteristics of a business and of the simple mathematics underlying them, clearly supporting the contention that there is an engineering approach to profit-making. In the second we indicated the effect of varying monthly sales volume proportions on profit and loss, because of the changing combinations of the fixed and variable costs in these varying proportions. In this installment, we have shown that with a knowledge of fixed and variable rates by products, plus a knowledge of monthly sales and productions, either predetermined or actual, *we can budget costs and forecast profits on a "variable" basis.*

Bringing the entire presentation to a focus, we can say that we have outlined, all too briefly perhaps, the essentials in what can be termed *profit control budgeting.* Knowing the fixed and variable cost characteristics, we can take steps to better the adverse ones. Being able to plan in advance for quantitative sales goals, we are in a position to work continuously toward the objective of a logical monthly sales proportioning. Being able to forecast the results of our efforts, as well as trace the causes of variations from a planned performance, we are in a position constantly to better our work.

In short, we have a technique whereby we can plan and get *better sales and greater profits.*

[This is the last of three articles by C. E. Knoeppel outlining the fundamentals of profit control budgeting. For earlier articles in this series see "An Approach to Profit," January, page 18, and "Profit Planning," February, page 62.—Ed.]

You Want to Know

. . . and the editors will gladly tell you . . . more about the things mentioned on this page

• PORCELAIN ENAMEL, recently announced, is said to achieve a greater degree of opacity, hence depth of color, in two coatings and firings than has heretofore been possible with three.

• BEESWAX users, note that there's a real mineral substitute, white in color, with a melting point of 160 degrees.

• CORK TILE, newly offered, comes in two thicknesses. You can also get covered angle and wall base as well as a special heavy density tile for stairways.

• QUICK-SETTING, acid-proof cement can be used like ordinary mortar, hardens into porcelain-like structure. Resists water, oil, hot and cold acids (not hydrofluoric), heat up to 2,000 deg. F.

• VENTING screw cap for vacuum packed foods is hereby nominated as best closure of the month. Said to be able to hold a 25- to 27-in. vacuum. Pressure with ordinary match will admit air so that the cap may be easily unscrewed.

• ALL-PURPOSE check protector not only prints dollar sign on checks, but also symbols like lb., ft., gal., so that it may be used on bills of lading, etc., as protection against fraud of one sort or another.

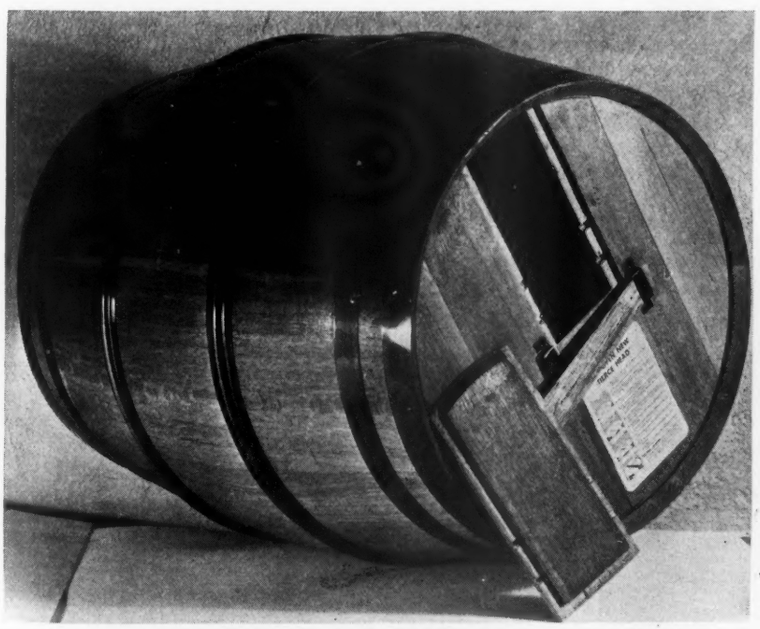
• TWINE, manila paper covered, comes in 5-lb. cartons. Easier to handle. Twine is kept clean, free from snarls.

• ROOFS made of copper sheets only 0.7 mm. thick and plastic asphalt, cost less, are said to be better than regular copper roofs.

• NO fogged lenses, no blurred vision, with a new goggle for "hot workers." It's ventilated.

• BOILED DOWN to 10 pages, "The Facts About Old Age Security"—a brand-new booklet.

• ALL-STEEL, spot-welded, soundproof telephone booth carries a fan that starts when the door is closed.



If your product is shipped in barrels, you'll want to investigate this 4-piece quick-removable tierce heading. Drive out the wedge, strike out the center section—it's in two parts—and the whole top comes out. Put the pieces back whenever you like and your barrel has a head again

• DEGREASING is easier with a concentrate that can be mixed as needed with water or kerosene to dissolve mineral oils, grease, grime.

• WRAPPING material, mostly wax, is impervious to water and humid atmospheric conditions. With a little heat and slight pressure it can be shaped to form watertight seals.

• MANY automotive manufacturers are packing service parts in metal-edged, grease-impervious boxes.

• MULTIPLE-STROKE lift trucks —one of 3,500-lb. capacity, the other 6,000—lift load with 8 short or 4 full strokes. Every stroke's the same. No hard ones.

• WHERE to look for lighting inadequacies and waste, and how to check and correct them—told in a booklet you can get free.

• FABRIC—washable, waterproof, immune to climatic changes. Has a synthetic resinoid calendered into its interstices.

• FOR WELDERS' HELMETS, a new glass that has been processed to prevent hot metal from pitting or sticking to it.

• EXPLOSION-PROOF lighting fixture is designed for atmospheres containing vapors of gasoline, naphtha, petrolem, alcohol, acetone, lacquer solvents, natural gas.

• BEARING MATERIAL—asbestos, graphite, and rubber—runs continuously submerged in water. Water is its best lubricant.

• LUMINESCENT PAINT, just developed, contains no radio-active matter, is neither inflammable nor toxic. For fire extinguishers, parts of machinery, projecting beams, staircases, or what have you?

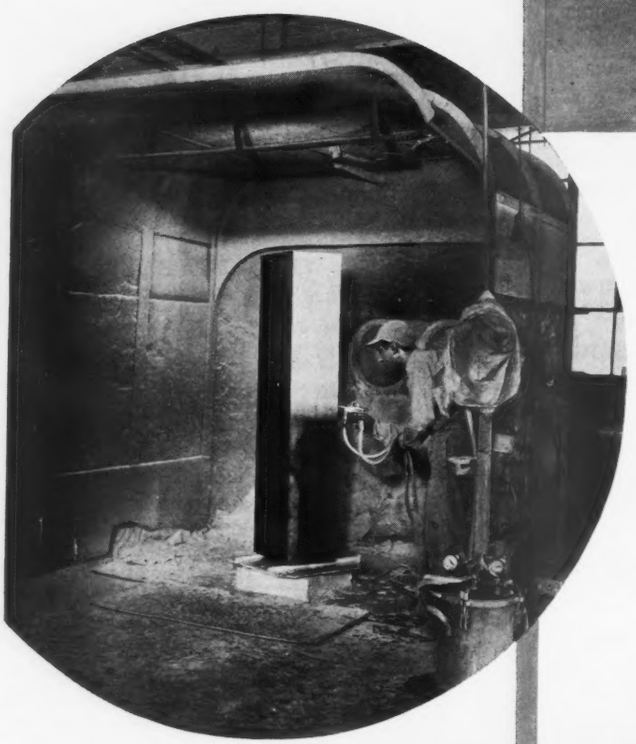
• CANISTER gas masks should be carefully selected with reference to the hazard to be met. One concern offers them for a wide range of industrial gases and fumes.

• LIGHTWEIGHT, translucent, completely waterproof fabric, made from silk, contains no rubber, is said to be acid-proof, heat-proof, won't crack, stick, harden, or deteriorate with age.

• MERCHANDISING highspot. There's an umbrella with hollow molded handle in which the wife carries her rubber sandals.

Painting the Product

Presents few difficulties if you have the right paint, the right spray gun, and the right booth



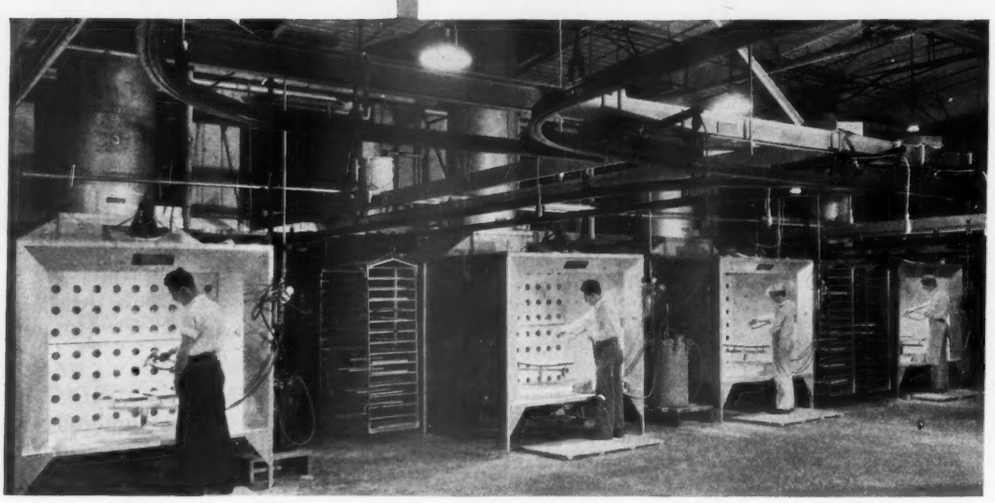
It looks as if it might be rather good fun painting perfume atomizers on the fly. De Vilbiss makes them, naturally uses its own equipment to finish them. One girl loads and unloads. The other aims and fires as the bottles pass in review. A baby spray booth—it's really twins—makes spray painting a safe and not unpleasant job

•

One operator spray finishes 80 utility cabinets a day at the Steel Equipment Company, Avenel, N. J., using 20 gallons of special heavy lacquer for a one-coat white finish. This plant is standardized on low-pressure equipment, believes it saves material, gives smoother finishes. The fact that less air is needed made it unnecessary to install a new compressor

•

At Edison General Electric Appliance Company, Chicago, a battery of ten water-wash reclaiming-type booths handle volume production on Hotpoint stoves. Six of them are conveyor fed. Company engineers say the water-wash feature has reduced enamel loss from 18.6 to 2.2 per cent. The figures say $17,000 saved in a single year



OPERATING SHORTS

Portable Lighting System for Storage Yard

LIONEL G. DAVID, *Chief Engineer*
Mt. Tom Sulphite and Pulp Company
Northampton, Mass.

It became necessary to devise a portable lighting system for a movable conveyor taking pulp wood from a storage pile 600 ft. long, 400 ft. wide, and 65 ft. high. One of the requirements was that the lighting units should be moved daily a distance of about 5 ft. toward the pile, as it diminished in size. After trying several schemes the one shown here was found to be the most economical and reliable. Also, it has the advantage of not requiring the use of a ladder for lamp renewals.

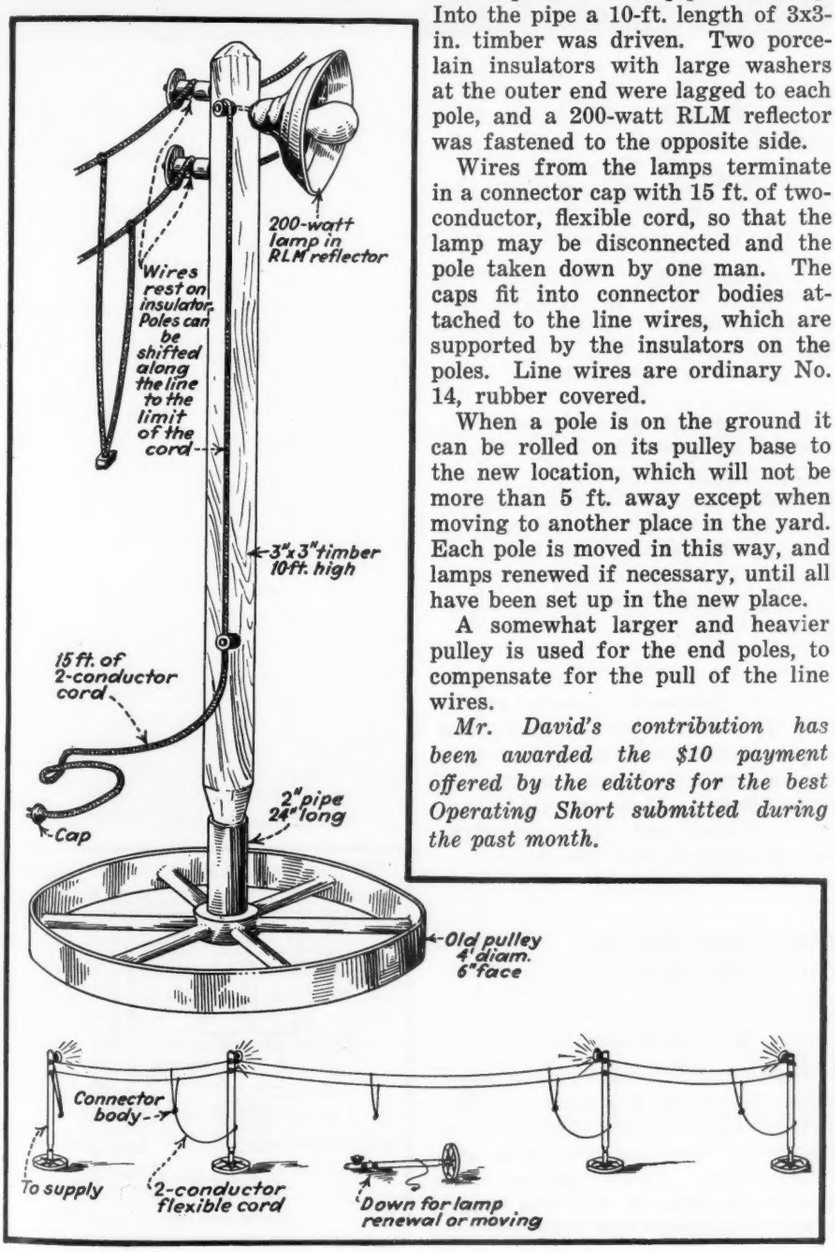
Hubs of some discarded cast-iron pulleys about 4 ft. in diameter and having a 6-in. face were bored to take a piece of 2-in. pipe 2 ft. long. Into the pipe a 10-ft. length of 3x3-in. timber was driven. Two porcelain insulators with large washers at the outer end were lagged to each pole, and a 200-watt RLM reflector was fastened to the opposite side.

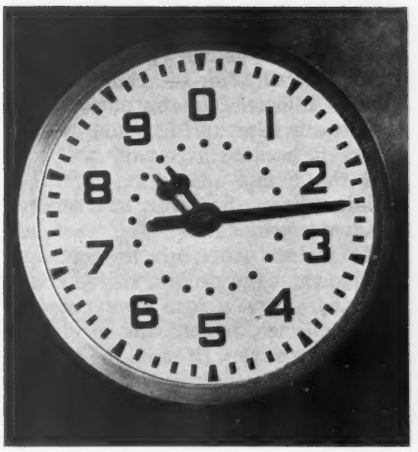
Wires from the lamps terminate in a connector cap with 15 ft. of two-conductor, flexible cord, so that the lamp may be disconnected and the pole taken down by one man. The caps fit into connector bodies attached to the line wires, which are supported by the insulators on the poles. Line wires are ordinary No. 14, rubber covered.

When a pole is on the ground it can be rolled on its pulley base to the new location, which will not be more than 5 ft. away except when moving to another place in the yard. Each pole is moved in this way, and lamps renewed if necessary, until all have been set up in the new place.

A somewhat larger and heavier pulley is used for the end poles, to compensate for the pull of the line wires.

Mr. David's contribution has been awarded the $10 payment offered by the editors for the best Operating Short submitted during the past month.


200-watt lamp in RLM reflector
Wires rest on insulator. Poles can be shifted along the line to the limit of the cord
3"x3" timber 10 ft. high
15 ft. of 2-conductor cord
Cap
2" pipe 24" long
Old pulley 4' diam. 6" face
Connector body
To supply
2-conductor flexible cord
Down for lamp renewal or moving



A Motion Study Clock That Measures "Winks"

In making motion studies by means of the moving picture camera, one accepted method of timing operations has been to photograph a clock with fast-moving hands, in the same field of vision as the operation being studied.

Generally these clocks have had to be improvised out of old phonograph movements or by home-made gearing of regular clock movements. The clock shown was constructed for use in time-study classes at Northwestern University.

An 8-in. dial is attached to a standard 110-volt, a.c., synchronous-motor-driven clock movement. A special gear ratio applied to the minute-hand shaft of the movement revolves the short hand once a minute, the long hand 20 times a minute. The dial is numbered to 10 instead of 12, so that each division constitutes two "winks" (Gilbreth's time unit of 1/200 minute). Folding legs and a hook on the back provide for convenient mounting of the clock in the field of vision of the camera.

•

Belted Pump Drive Cut Cost

C. O. VON DANNENBERG
Brooklyn, N. Y.

A manufacturing process required the transfer of a dilute sulphuric acid solution from a tank to a distant point. For this service ten centrifugal pumps driven by vertical-shaft, slipring, induction motors had been installed.

At first the pumps had been operated at a lower speed, to obtain a certain output, by inserting resistance in the rotor circuit. This

resistance was reduced as the pump impeller was eaten away by the acid. Speeding up of the pump as the diameter of the impeller grew smaller allowed the output of the pump to be kept up for a long period before it became necessary to overhaul the pump.

This scheme, however, had several disadvantages. First, the vertical-shaft motors were much more expensive than the ordinary type. Second, there was a loss of energy in the resistance, which was in circuit for most of the life of the pump. Also, it was necessary to use a comparatively slow-speed motor (7.5 hp., 600 r.p.m.) in order to suit the pump speed.

Another practical disadvantage lay in the fact that the motors were close to the tank, so that in the event of an overflow it was possible for acid to pour over the motors.

To remedy these situations, standard 1,200-r.p.m. motors of the squirrel-cage type with horizontal shafts were installed in housings located a short distance from the pumps. A pulley was placed on each pump shaft and a belt with a quarter turn was installed between the pump and the motor.

Now when the pump impellers become worn sufficiently to reduce the discharge a larger pulley is put on the motor shaft. This change is easily made with such a small motor.

The apparent disadvantages of having a belted drive and the need for periodic changing of the pulleys were found to be minor factors compared to the advantages resulting from this change.

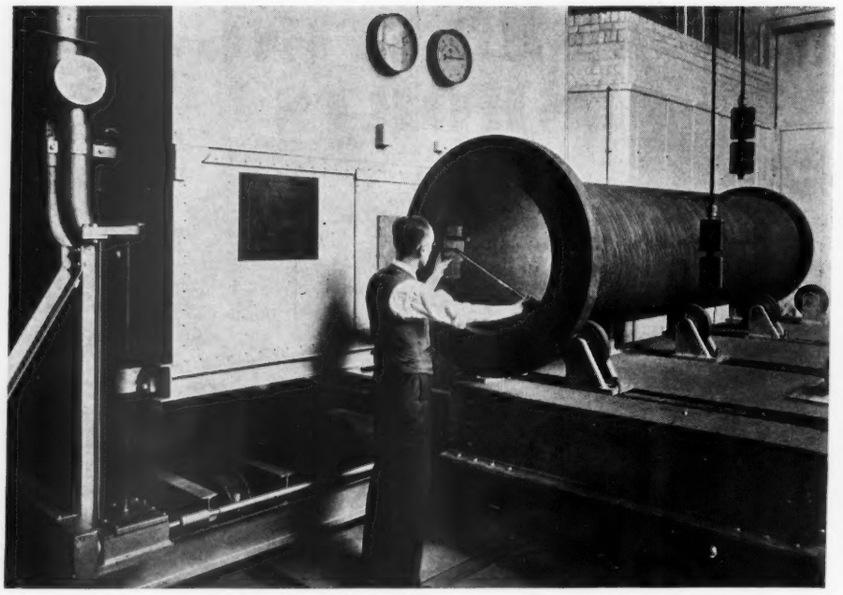
•

Tool Cabinet Made from Lockers

J. MURPHY, *Murphy Tool Company*
Lakewood, Ohio

When, recently, we had need of a storage cabinet for such tools as milling cutters and drills we decided to make use of an unused section of steel lockers. After the doors were removed the section of lockers was set up horizontally and fastened to the brick wall with lagscrews. This arrangement gave us a six-tier shelf cabinet at no expense and almost no work.

If we had wanted a better-looking job the legs of the lockers could have been cut off and a metal panel fitted in their place. Also, if a locked compartment had been needed, one of the doors could have been left on.



Finding Faults with the X-Ray

SOURCE, *Westinghouse Electric & Manufacturing Company*
South Philadelphia

Supplementing visual inspection, X-rays are used to detect hidden defects in welded parts. Cylinders and shells are brought to the X-ray machine on a battery-driven truck with pushbutton control.

The machine is housed in the cabinet in the foreground, which can be raised or lowered by motor-driven screws. A pointed, telescopic rod with a spiral spring inclosed between the two sections keeps the photographic plate holder firmly in position, inside the cylinder under test.

•

A Baltimore concern organized 16 of its younger men as a Junior Board of Directors, meeting once a month to discuss plant problems. Result: Many workable suggestions made and every recommendation adopted with benefit.

•

Emergency Starter for 15-Hp. Motor

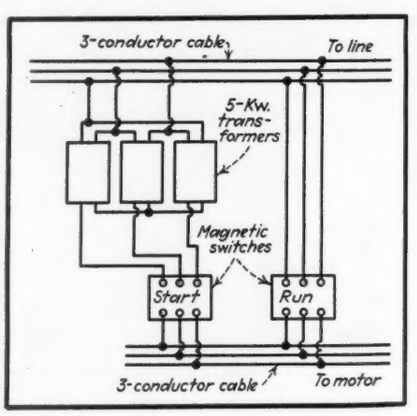
C. E. STEPHENSON
Winston-Salem, N. C.

Recently a pushbutton-controlled, magnetic starter operating a 15-hp., three-phase, 550-volt, 60-cycle motor on a very important production machine failed. There was no extra starter in stock, so one was improvised from three 5-kw., 600/220-volt, single-phase, air-cooled transformers and two magnetic switches. It served until the original could be repaired.

The transformers and switches were placed on a truck and the primaries of the transformers connected in delta, the secondaries in star, as shown. The three leads from the primary side were connected to a piece of three-conductor cable which also was connected to the line side of one switch. This cable was tagged "Line." The three leads from the secondaries were connected to the line side of the second switch. The load sides of both switches were then connected to another piece of three-conductor cable which was tagged **"Motor."**

These cables were connected to corresponding temporary wires installed while the transformers were being connected. The coil of the switch connected to the transformers was connected to the original Start button and coil of the other switch to the original Run button.

In this manner the motor was



started at reduced voltage through the transformers, then thrown directly across the line. The transformers could have been connected in delta-delta for slower starting, or, if only two transformers had been available, they could have been connected in open delta.

•

"A plant within a plant" was the answer in a Cleveland concern which had trouble getting accuracy on a boring job. Inner plant seals out metallic dust, keeps temperature more even, has special lighting.

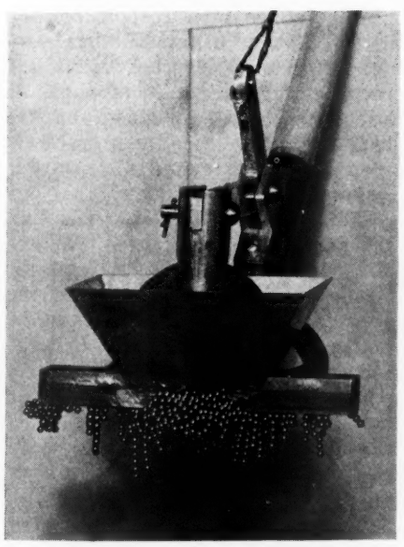
•

Mopping Up Steel Balls

SOURCE, *General Electric Company Schenectady, N. Y.*

There is now such a thing as a magic mop. It was evolved as the answer to a minor manufacturing problem that caused more irritation than damage.

In certain operations large quantities of steel balls and shot are used —and spilled on the floor. To facilitate salvaging of this material an



ordinary mopstick was equipped with a brass hopper, soft iron polepieces, and a sliding magnet the position of which is controlled by a wire.

When the magnet is down the polepieces pick up the steel balls and shot. Lifting the magnet allows them to drop off into a receptacle.

•

"Day Light" lamps in R.L.M. reflectors aid color discrimination in a Brooklyn, N. Y., label-manufacturing plant, speed up work, reduce errors.

Use Number Plates for Marking Motors

S. H. COLEMAN, *Waynesboro, Va.*

Where records are kept of a large number of motors the problem of permanently numbering each one is of great importance. In one large plant where motors are subjected to corrosive gases in the atmosphere, a number of marking methods were tried and found unsatisfactory. Among the methods tried were:

1. Painting the number on the motor. In many cases the number was painted out or obliterated.
2. Stenciling the number on the nameplate. Numbers were often blotted out by corrosion, the nameplates were lost, or where they were fastened to the frames, the frames were transposed in the repair shop.
3. Stenciling the number on frame, stator laminations, or endbells. Trouble arose from paint filling in the stencil marks, and from transposition in the shop.
4. Stenciled metal tags fastened to through bolts. Tags were often lost when work was done on the motor.

Eventually a method of marking was worked out which has proved very satisfactory. Small plates of non-corrosive metal with the motor number stenciled in raised figures are fastened to the stator laminations. Permanence of fastening is assured by securing the numeral plate at each end with non-corrosive, round-head rivets driven into holes a few thousandths undersize drilled into the stator laminations.

On motors of the totally or semi-inclosed types, the numeral plates are fastened with machine screws to the stator shell. Although this latter procedure is not completely satisfactory, because of the possibility of the shells becoming transposed, it is a great improvement over any of the other methods tried.

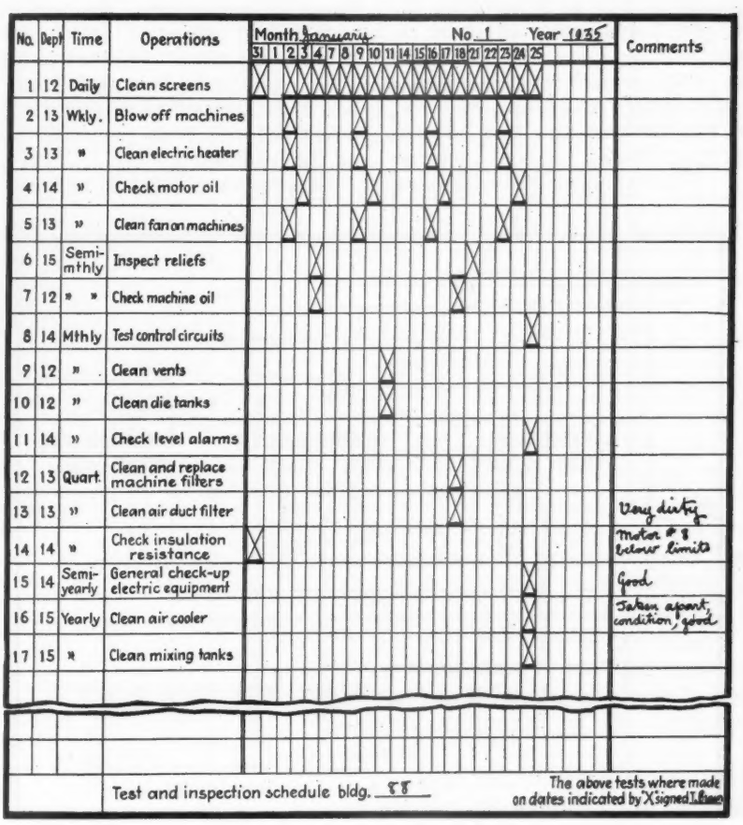
•

Keeping Track of Scheduled Maintenance

P. LINDHOLM, *Newark, N. J.*

The chart shown has been very helpful where it is necessary to keep a record of important tests or inspections. With it, maintenance activities may be graphically scheduled. And it shows at a glance the status of the work for the entire month.

When an inspection or test is to be made it is indicated by a red underscored line in the block corresponding to the number of the test and the date on which it should be made. If the test is not made, that fact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31 1 2 3 4 7 8 9 10 11 14 15 16 17 18 21 22 23 24 25
Comments
1 12 Daily Clean screens
2 13 Wkly. Blow off machines
3 13 » Clean electric heater
4 14 » Check motor oil
5 13 » Clean fan on machines
6 15 Semi-mthly Inspect reliefs
7 12 » » Check machine oil
8 14 Mthly Test control circuits
9 12 » Clean vents
10 12 » Clean die tanks
11 14 » Check level alarms
12 13 Quart. Clean and replace machine filters
13 13 » Clean air duct filter
Very dirty
14 14 » Check insulation resistance
Motor # 3 below limits
15 14 Semi-yearly General check-up electric equipment
Good
16 15 Yearly Clean air cooler
Taken apart, condition good
17 15 » Clean mixing tanks
Test and inspection schedule bldg. 88
The above tests where made on dates indicated by X Signed J. Lindholm

will clearly be shown, since the "X" will not appear in the block for the test date. It will be noticed on the chart that test No. 6 was made one working day late.

There is a record for each regular working day in the month. A complete record for the year consists of only twelve sheets.

The comment column on the right is used for notes when they are necessary. Ordinarily, if equipment is found to be in good condition, no comment is made.

Although several persons are necessary to make the inspections, only one person is responsible for seeing that the work is done and the chart kept up to date.

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Electric eyes test the quality of glass used in goggles made by Willson Products, Inc., Reading, Pa. Operate with indicating meters which register light transmitted through sample.

•

Emergency Replacement of Burned-Out Transformer

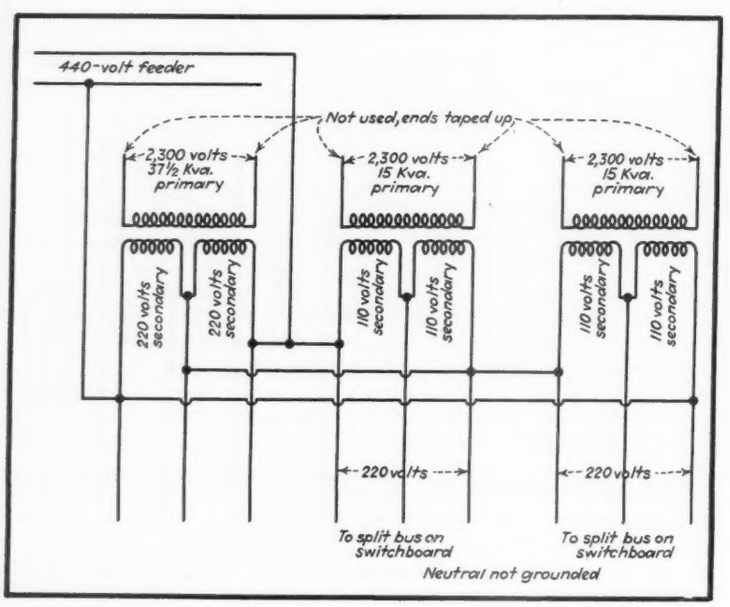
When a 75-kva. single-phase transformer with a 440-volt primary and 220/110-volt secondary burned out, the emergency hookup shown was used to supply current to certain equipment in a large plant until the burned-out transformer could be rewound.

The only transformers available on short notice were one 37½-kva., 2,300/440/220-volt and two 15-kva., 2,300/220/110-volt, single-phase units. Since the burned-out 75-kva. transformer fed a bus on a panelboard with several branch feeders, the bus was split and each half fed by one 15-kva. transformer.

The 2,300-volt leads were taped up so as to prevent accidental contact, inasmuch as putting 440 volts on the secondary side induced 2,300 volts on the primary, which was not needed when using the secondary winding as a balance coil.

It will readily be seen that with balanced conditions the emergency transformers were able to carry the total load of the burned-out transformer.

This hookup required that the conventional grounded neutral be dispensed with, but when the original transformer was put back in service the neutral had to be grounded again.



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Less Walking, More Work

JOHN A. HONEGGER, *New York*

At the laboratory of the Geophysical Research Corporation, Tulsa, Okla., many of the geological survey instruments manufactured require the making and fitting of numerous small pins and shafts.

To facilitate this work a watchmaker's lathe and a small motor were mounted on a sturdy stand fitted with casters. On the other end of the stand a small, motor-driven, sensitive drill was placed. This equipment is rolled from one bench to another as required, power being secured from the wall outlets at the benches.

Less walking between benches and machines is now required of the workmen. Tying up of important equipment on inconsequential jobs has been eliminated. Workmen remain seated for final assembly work.

A noticeable increase in production was evident after this tool-bearing stand was made available.

SPECIAL NOTICE

$10 will be paid for the best Operating Short submitted during the month of March. The Editors are the judges. Other Shorts accepted will be paid for at attractive space rates

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What About Creeping of Inner Bearing Races?

JOHN E. HYLER, *Peoria, Ill.*

Maintenance men responsible for the installation of anti-friction bearings are sometimes confused about creeping of the inner race. Some fit the bearing loosely enough on the shaft to allow the inner race to creep; others condemn this practice. Just what should be done?

There is no hard-and-fast rule that will apply in all instances. Where the speed is relatively low and the load heavy, it is well to fit a bearing loose enough to permit creeping of the inner race, especially on installations where a revolving member runs on a stationary shaft. With high speeds, creeping of the inner race is very bad. Where the bearing is mounted on a rotating shaft nothing is gained by allowing the race to creep; hence, all such installations should be light press fits, tight enough to make the inner race stick.

One may question where the advantage lies in allowing creeping of the race on stationary-shaft installations. A case in point is a shop truck with a non-rotating axle, the wheel being fitted with a tapered roller bearing. If the inner race, or cone, is put on the non-rotating axle so tightly that it cannot creep, the heavy load pressure will at all times be localized at one point—on the under side of the cone. If the cone be allowed to creep, the load and the wear are distributed around the cone.

Let's Look Into Electron Tubes

Knowing how they work, what their capabilities and limitations are, will help you apply them successfully

R. H. ROGERS
Industrial Engineering Department
General Electric Company
Schenectady, N. Y.

INDUSTRY makes use of only a few types of electron tubes, and a few fundamental functions serve for a great variety of practical applications. Tubes and their related apparatus have been combined into sturdy units that are applied on and about machines with the assurance associated with better known control devices. New uses for these comparatively new tools are being found almost daily. However, successful application of electron tubes depends on a thorough knowledge of how they function and what their capabilities and limitations are.

What They Are

Electron tubes comprise a simple terminal called the anode, another called the cathode, from which electrons can be driven by heat or light, and, in many tubes, a grid which is primarily for control. The degree of vacuum used is important and requires some explanation.

Normal atmospheric pressure will support a column of mercury 760 mm. high—the familiar 30-in. barometer reading. The 28-in. vacuum of the steam engineer supports a 2-in., or 51-mm. column of mercury. A "low" vacuum used in tubes which may contain mercury vapor, or a mixture of vapors and inert gases, may be rated from 2 mm. to 1/10 mm. A "high" vacuum, the best obtainable, rates only 0.000076 mm. or one ten-billionth of an atmosphere. This is equivalent to a drinking glass full of air in a tunnel 10 feet square and 15 miles long!

Several thousand volts are required to start an arc across a gap; once established, only a few volts are needed to maintain it. Something has broken down the resistance of the gap; so it is said to be ionized. The space between the anode and the cathode in a tube cannot be jumped by any reasonable voltage, but it can be made to conduct current easily.

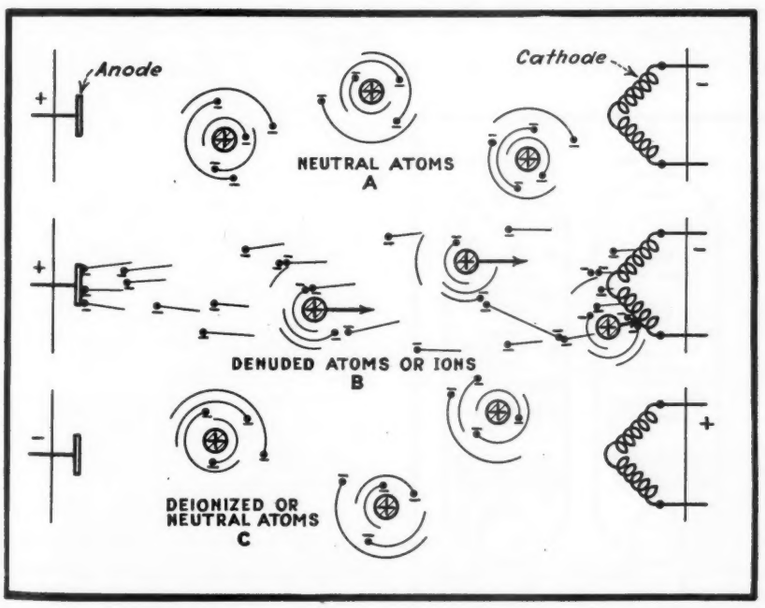


Figure 1. When the cathode of an electron tube is cold, *A*, there are no free electrons; hence, no current flow. From a heated cathode, *B*, electrons are driven out and are attracted to the positively charged anode. If the potential of the anode or cathode is changed, *C*, or the cathode becomes cold, the flow of electrons ceases and the atoms become deionized

How They Work

What goes on in an electron tube is shown in Figure 1. In diagram *A*, with positive potential on the anode and negative on the cold cathode, nothing happens; the intervening atoms are undisturbed. If the cathode is heated, as in *B*, free negative electrons are driven out and rush to the positive anode. On their way they collide with the atoms and tear loose some of their electrons, which in turn collide with other atoms, adding to the general procession toward the anode. The denuded atoms, now positive in potential, are called ions; they move toward the negative cathode, are reclothed with electrons and are then said to be "deionized" or returned to their complete and neutral state.

If the anode becomes neutral or negative, if the cathode becomes neutral or positive, or if the cathode is cold, no stream of electrons can flow and the whole content of atoms becomes deionized (diagram *C*).

The flow of electrons from cathode to anode provides the transportation system for the flow of electric current, which sets up a wave motion through the electrons at the velocity of light. It takes six million, million, million electrons per second to pass 1 ampere of current. They are provided largely by collisions in the low-vacuum tubes, since probably a million electrons reach the anode for every one that leaves the cathode. This is not true of the high-vacuum tubes; in them the cathode is designed to furnish all the electrons needed.

Starting and stopping of the flow of current through a tube having

only an anode and a cathode can be controlled by the presence or absence of a positive potential at the anode. The quantity of current flowing can be varied directly by increasing or decreasing the positive potential at the anode.

Such a tube having a high vacuum and resultant high internal voltage drop is known as a Kenotron tube. Its current-carrying capacity is limited to a few thousandths of an ampere. With a low-vacuum tube containing mercury vapor, say, the internal voltage drop is low and the tube output is read in amperes. This type is called a Phanotron tube.

How They Are Controlled

Presence of the third member, the grid, provides another means of control. It is placed in the path of the electrons escaping from the cathode; if the grid is also negative, the electrons are shielded from the positive anode and no current can flow, except as may be noted later.

If the grid is positive, it presents no obstruction to the electrons and current can flow. The high-vacuum-type tube with a grid is the Pliotron, well known in radio. Its current-carrying capacity is limited to milliamperes.

The low-vacuum tube with a grid is known as the Thyratron. It has great current-carrying capacity, even thousands of amperes instantaneous discharge. Control is more limited than in the Pliotron tube in that when current flow is established, the grid cannot regain control and stop it unless impracticably large potentials are applied. It must wait for an instant of no potential or negative potential on the anode; then, if the grid is negative, the flow cannot restart. Starting can be restricted, however, to any desired point of the positive half-wave; hence the unidirectional or direct current can be controlled, since it is the average value of a series of all positive half-waves or of predetermined parts of half-waves.

The Thyratron is the work horse in industrial applications and the tube most frequently heard of, next to the phototube.

The phototube may be either a high- or low-vacuum unit, with only an anode and a cathode. The cathode is cold but is made large, say 1 square inch in area, and is coated with caesium. Electrons are released by light, instead of by heat. The flow of electrons and therefore of current is started, stopped, and regulated by the presence, absence, and intensity of light on the cathode. This tube is able to carry only a few millionths of an ampere.

Five kinds of tubes, Figure 2, are therefore available for industrial application:

1. Two-electrode Kenotron: high vacuum, high voltage, low current, limited control.

2. Two-electrode Phanotron: low vacuum, low voltage, high current, limited control.

3. Three-electrode Kenotron, or Pliotron: high vacuum, high voltage, low current, accurate control by grid potential.

4. Three-electrode Phanotron, or Thyratron: low vacuum, low voltage, high current, highly practical control by grid potential.

5. Phototube: high or low vacuum with argon gas, voltage dependent on vacuum, passes microamperes of current, highly practical control by light intensity.

These tubes are produced in many sizes and forms. All-metal tubes which are more sturdy and have a greater output for a given size because of superior heat radiation are coming into use. Glass tubes, however, have proved themselves amply strong for industrial work.

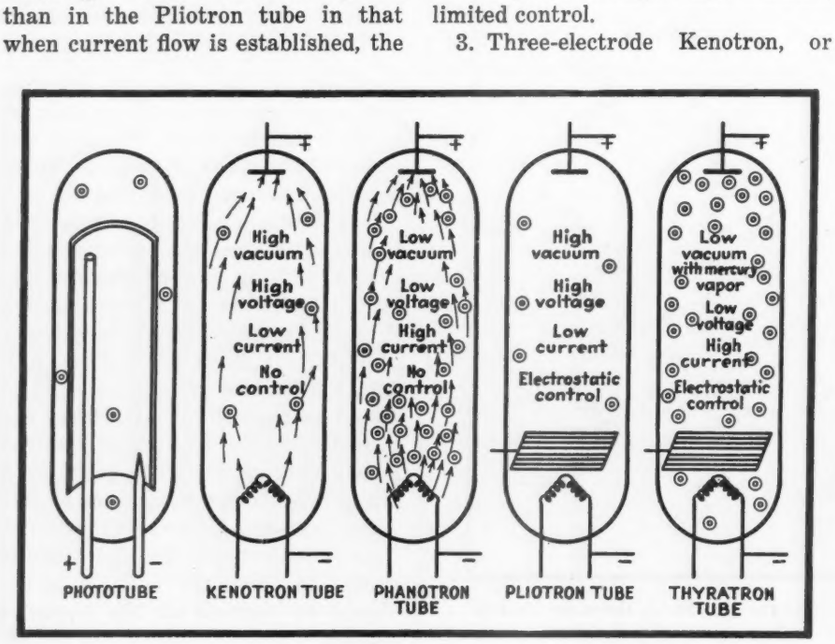


Figure 2. Types and characteristics of electron tubes finding industrial application

What Accessories

Accessories used with tubes may include one or more of the following: transformers, potentiometers, variable or fixed resistors or capacitors (condensers), fixed, movable core or saturable reactors, relays, clock-motors, switches.

Although assemblages of tubes and accessories as they are used in industry accomplish the results normally associated with the following devices, they may function in entirely different ways and in some cases only to a limited extent, as compared with analogous apparatus:

Switch: to interrupt or close a circuit.

Relay: to affect other devices in the same or another circuit upon specified changes in the circuit conditions.

Rectifier: to convert alternating to direct current (or at least to unidirectional current).

Inverter: to convert direct to alternating current.

Frequency changer: to change alternating current from one frequency to another.

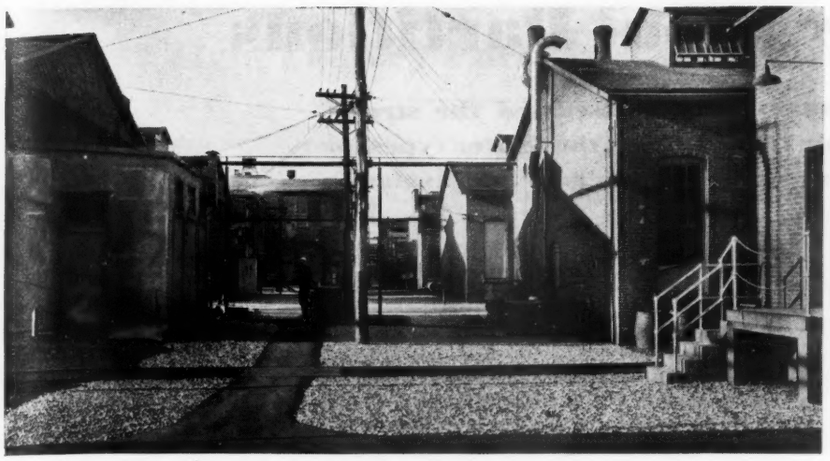
Amplifier: to change small voltage or current values to higher values.

Rheostat: to adjust and control circuit conditions.

Switching operations are carried out by phototubes which close the circuit upon application of light and open it when the light is removed, or *vice versa*.

The grid-controlled tubes, the Pliotron and Thyratron, act to close

(Continued on advertising page 56)



Pebbles cover areas between roads and buildings where grass wouldn't grow

Not Dusty Any More

When outside dirt made inside cleanliness difficult, this concern used graded pebbles

HENRY W. JOHNSTONE
Plant Manager
Merck & Company, Inc., Rahway, N. J.

IN THE manufacture of fine chemicals, cleanliness is of paramount importance. Every precaution must be taken to insure the physical as well as the chemical quality of our products. This involves elimination of dust and cinders carried by wind from the factory yard or the neighboring railroad.

Many of the larger open areas about our plant have been sown to grass, but grass is impractical immediately adjacent to our manufacturing buildings. Oil and calcium chloride have been used in these areas, but their effects have proved neither lasting nor entirely satisfactory.

So We Tried Pebbles

Taking our cue from the method which the Hercules Powder Company used with marked success on a larger scale in combating wind-blown sand at its Parlin, N. J., plant, we finally resorted to graded pebbles.

The dirt and cinders between roadways and factory buildings were removed to a depth of 4 inches and the space was filled with pebbles screened to $\frac{7}{8}$—$1\frac{1}{2}$ inches and carefully washed. The work was done in conjunction with general repairs to our roads, for unless these are hard surfaced the effectiveness of the pebbles is largely nullified. For roadways we have standardized on a ready-mixed asphalt. This form of road construction was adopted because it is reasonable in cost, can be applied quickly, and is easily patched.

And Found They Worked Well

Results have been most satisfactory. The pebbles not only eliminate the eddies of dust that used to swirl around our factory buildings on windy days, but they also help absorb cinders and dirt blown from the railroad and other untreated areas.

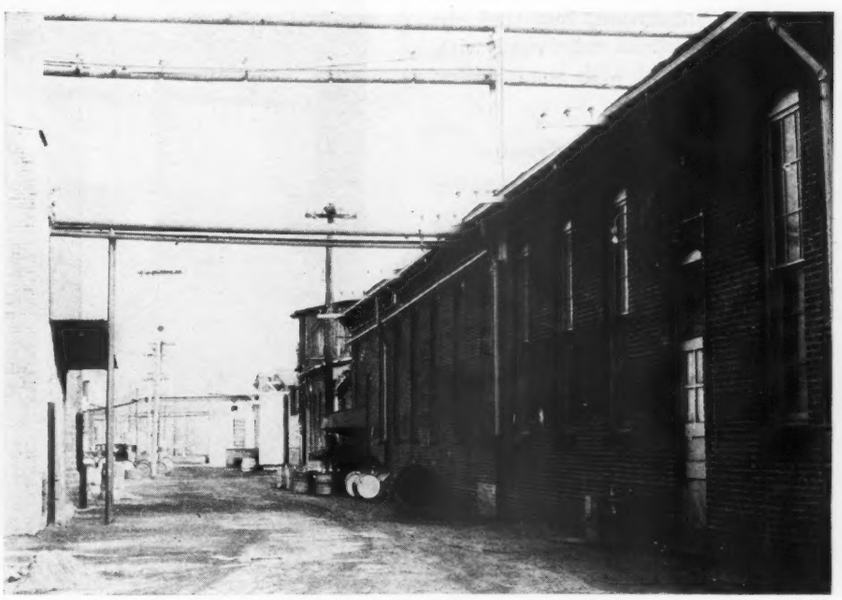
The spreading of pebbles in the areas alongside buildings has not reduced storage area. Drums are rolled into place on stringers; carboys and other containers are stacked on stringers or platforms.

Upkeep on the pebbled areas is practically nil. If it becomes necessary to get at underground lines or make excavations for tanks, the pebbles are easily removed and replaced. Drainage, too, has been improved.

One of the most interesting results has been the psychological effect. There is much less carelessness in disposing of rubbish; workmen take pride in stacking carboys carefully and in lining up drums and barrels.

We are so thoroughly convinced that pebbles are the answer to our particular problem that we plan to cover other and larger areas as rapidly as our budget will permit.

Dust and cinders swirled about before the pebbles were brought in



More About Partitions

A January article discussed the strong, durable types. Here, the lighter types for offices, stock rooms, general insulation

G. W. BORDEN
Construction Engineer, New York Dock Company
New York

STRENGTH and durability are not always necessary in factory partitions. Often their purpose is to separate light manufacturing or other operations, offices, and stock or file rooms. Such partitions can be of light construction, built principally for insulation from heat, cold, dust, noise, or odors, for preventing trespass, or for privacy.

The first consideration in selection of type for light partitions must of course be the purpose to be served. The secondary controlling factors will be cost of installation and appearance. Cost need not be so great a factor as to eliminate any of the purposes the partition should serve, and appearance, outside of the structural features, is superficial and can be varied at will.

The simplest type of partition consists of wood studs, usually 2 x 4 in., covered on one or both sides with wire mesh, wood sheathing, composition boards, or sheet metal. Studs faced both sides provide a dead air space that is a good insulating medium. Building papers placed over the studs before sheathing increase the insulation, but they do not last long unless reinforced with a mesh or backed with some stiffer material.

Look Out for Rodents, Termites

A much better form of insulation is obtained by packing the space between studs with some non-conducting material such as asbestos fiber, mineral wool, etc., keeping in mind that this material must eliminate rodents and termites and still not be offensive in any way to the factory. A proper product will have no sustenance value for termites, be partially poisonous to insects or rodents, yet serve the original purpose—insulation.

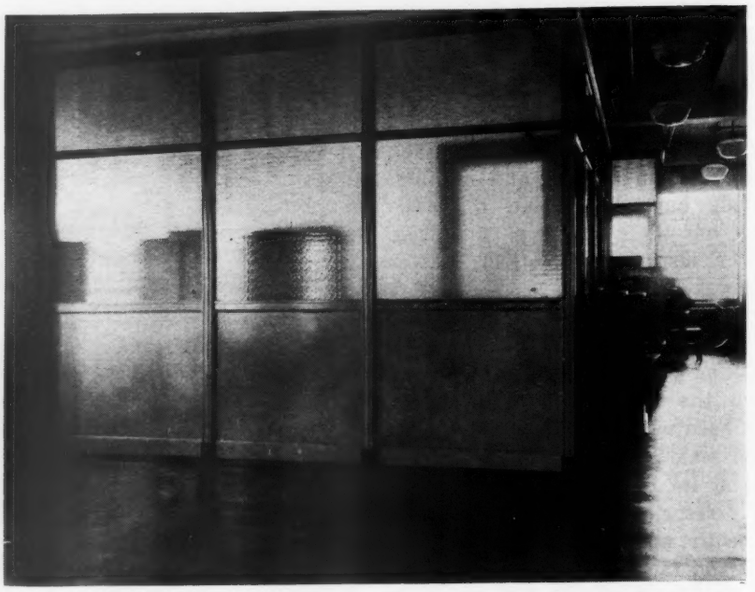
This type of partition was long used almost exclusively where masonry was not needed, still is one of the cheapest types. But in late years, factories have had to face new problems arising from the use of machinery and chemicals. Insulation from noises, dust, and fumes has become as pertinent to comfort and efficiency as is insulation from heat and cold. Products in one part of a building may be ruined in process or storage by the by-products or processes of manufacture in adjacent areas. These problems have led to many changes in partition materials in a search for satisfactory solutions, and these solutions in turn have led to several different types of partitions.

When You Have to Insulate

All such partitions are based on the same principle of intermediate stiffening by studs of steel, wood, or sheet metal bent or pressed into hollow sections. Over or between these studs is placed the covering or filler, which may be of wood, in board or panel form, pressed fibers, composition boards, or flat metal in plain, panel, or pressed form. For insulation purposes these partitions often have two faces, between which is either a dead air space or a material that is a non-conductor of heat or sound and that is dense enough to prevent penetration of dust or odors. Such materials as cork, asbestos, pressed fibers, mineral wools, and treated wood are usually suitable.

Concerning Windows and Doors

If windows are needed for light and must be insulated, they can be made double with an air space between the glasses. Doors of pressed-steel, hollow metal, or laminated type, with insulating binders, are light yet serve the purpose of insulation. If ventilation is needed, a system of ducts and fans can supply clean air and eliminate foul air without admitting the nuisances that are being overcome by insulation.



Sectional, pre-fabricated partitions can be set up quickly, have high salvage value, good appearance

Light Factory Partitions

General Description	*Approx. Cost per Sq.Ft. in $*	*Remarks*
Ordinary 2x4-in. studs, about 16-in. spacing, center-braced and covered two sides with:	0.05	Usual basis of all light partitions except sectional type.
1 layer of ⅞-in. tongue and groove or shiplap sheathing;	0.30	Usually in factory area, stock or file rooms. Surface not easily damaged.
1 layer of No. 20 gage galvanized sheet metal	0.30	Appearance, unfinished.
Composition boards of pressed paper, wood, or cane fiber	0.25 to 0.40	Usually for offices, stock or file rooms. Surface more easily damaged. Appearance more finished. Should be kept dry.
Wood panels—oak or maple	0.35 to 0.50	Mostly for offices. Not rugged enough for factory areas. Must be kept dry to prevent warping. Stained or painted finish makes excellent appearance.
For solid insulation in space, add	0.05 to 0.10	Materials should be fireproof or fire-retardant if possible.
Reinforced fibers or metal lath with ½-in. cement plaster	0.25 to 0.40	Quite strong. Use in factory offices, etc. Steel trowel finish makes smooth surface and finish can be greatly varied. Considered fireproof if filled solid with fireproof insulation material. Surface quite easily marred.
¾x1-in. furring strips on walls	0.03 to 0.05	Nailed to brick walls. Expansion shields needed for concrete walls. Should be placed on all damp or exterior walls before erecting partition.
Sectional sheet-metal partitions about 7 feet high with upper half glass or metal panels	0.50 to 1.00	Use in factory area, for offices, stock and file rooms, etc. Many possible combinations of paneling, glazing, doors, etc. Not easily damaged.
For flat metal, glass, or plaster board filler to ceiling (about 6 feet), add	0.30 to 0.50	
7 feet high with baked-on enamel finish	1.10 to 1.50	Enameled finishes more expensive but require no paint. Extra charges for doors, transoms, ventilators, chair rails, etc. Varying degrees of insulation are an added cost.
Painting—one face only, one coat, either priming or base coat	0.01 to 0.02	Smooth surfaces give better coverage than rough and can be painted faster. On large areas paint may be applied with spray guns, which, however, cause adjacent areas to become slightly covered with spray. Faster than hand painting. Brush painting requires no equipment, is clean and quiet, and although slower than spraying, necessary on all jobs for trimming and "cutting in." All surfaces must be entirely clean of loose particles, dirt, oils, etc., before applying paints.

Ordinarily the lighter sectional partitions are stiff enough, due to the presence of intermediate cross-partitions. In the absence of these, a series of metal braces can be fastened one on each side of a stud and extended to the ceiling.

For Flexibility

Some partitions are made like a series of doors which can be folded up or by-passed, or they can be raised to a horizontal position on the ceiling. This allows for a sub-dividing of areas when needed and a temporary elimination of partitions as desired. Other partitions, especially of metal, are built in stock sections and fastened with bolts or metal wedges so that they can be taken apart and re-installed as and where desired with very little additional material.

The question of durability rarely enters. Usage is not apt to be severe. Nor is ease of installation during plant operation important, since production is not greatly interfered with. Salvage value, likewise, has little bearing: the tendency, especially in the case of office partitions, is to renew them for the usual infrequent changes in location.

The next item of importance is appearance. This naturally varies with the tastes of the factory personnel. The appearance of a partition aside from its structural features, depends entirely upon the type of finish applied to its surface. Different color schemes and effects can be produced on most surfaces, often regardless of the materials used in the partition. However, it is not advisable to use highly enameled paints or bright colors having extreme reflection properties. Flat oil paints of white or light tint are usually best for factory spaces. Offices should be in tints of ivory, green, light brown, or some color helpful to the eyes. A dark area will require a lighter color and vice versa.

Other Finishes You Can Use

Many metal partitions have baked-on enamel in tints or colors as required, and although more expensive, can be washed with water or cleaned down with oils. Painting effects and imitations of wood can be placed on metal, smooth wood, composition boards, plaster, etc., with ordinary oil paints. Paper, fibers, etc., can be applied to smooth partitions and shellacked for protection, and they may be stamped or printed to represent different materials.

Wood partitions can be built on wood studs or with furring strips over masonry walls and made paneled or smooth as desired. An application of a stain coat will tend to show the wood grain more strongly and a coat of clear varnish will in turn protect the shellac.

In office partitions the eventual up-keep of appearance is as important as initial cost of installation, and the surface treatment should receive due thought. Private offices of officials and department heads usually are considerably better constructed and surfaced than are general offices and are consequently more costly. This difference in cost need not be so great if care is taken in choosing the right type of partition before actually starting the work. Ultimately the surface appearance is the really important item, and an expensive partition can be ruined by improper treatment. Conversely, a mediocre partition can with the proper care be surfaced to present a very creditable appearance.

How Much P. F. Correction?

Maximum return from power factor correction depends on getting the proper balance among several factors, including the important item of cost

WILLIAM E. BARBOUR, JR.
Electrical Engineer
Cambridge Electric Light Company
Cambridge, Mass.

ONE of the important questions that comes up when considering power factor correction is: How much corrective capacity is it desirable to install? Too often the answer is determined from the physical rather than economic standpoint. Correction to 90 per cent or 100 per cent power factor may show a substantial saving, but a dollars-and-cents study may indicate that the economical stopping point is at 92 or 93 per cent.

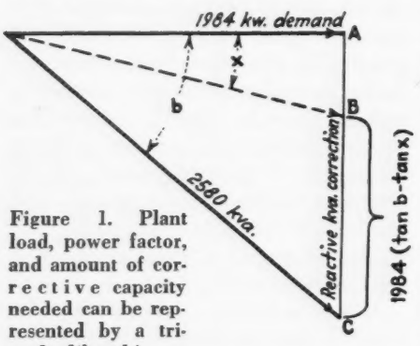


Figure 1. Plant load, power factor, and amount of corrective capacity needed can be represented by a triangle like this

There are four principal factors to consider in determining the amount of corrective apparatus that will effect the maximum saving:

1. Installed cost per reactive kva. of condenser;
2. Power factor clause in rate schedule;
3. Plant demand;
4. Expected return on investment.

What Rate of Return?

The first two items will be established facts at the start and need no explanation. Plant demand will in all probability vary throughout the day and from one season to another. A careful analysis of the trend of demands recorded during the past several years should furnish a fairly accurate indication for estimating future loads.

The item of expected return on the investment is more a matter of judgment than of concrete fact. The whole problem resolves itself into the simple question: What will capital in my business earn for me?

Obviously, if a 25 per cent return can be expected on $1,000 spent in advertising or in the processing of shoes, nails, or whatever the product happens to be, a 20 per cent return on power factor correction will hardly be attractive. If the percentage return desired on money spent in plant improvements has been established, it may be used as a basis for determining how much corrective capacity to install.

A Soap Factory Figures It Out

A specific example will bring out the details of economic power factor analysis more clearly than a mere discussion. A large soap manufacturing plant that was recently surveyed had an average billing demand of 2,190 kw. at 77 per cent power factor. The rate schedule contained the familiar bonus and penalty clause, and read as follows:

> "When the power factor is less than 80 per cent or more than 90 per cent, the billing demand shall be increased or decreased respectively in the ratio that 85 per cent bears to the power factor."

On this basis power demand was approximately $(77 \div 85) \times 2{,}190 = 1{,}984$ kw., the remainder or 206 kw. being units of power factor penalty.

Expressing the conditions graphically, in Figure 1, let b equal the present power factor angle and x the angle after corrective apparatus is installed. The condenser capacity in reactive kva. necessary to correct the power factor from cosine b to cosine x is $1{,}984\ x\ (\tan b - \tan x)$. Angle b is 39.6 deg. for a 77 per cent power factor.

It was found that static condensers could be installed for about $14.50 per kva. The total cost of correction would then be:

$$14.50 \times 1{,}984 \times (\tan b - \tan x)$$

Curves Tell the Story

If to this term the fourth factor is applied—the desired percentage return on the investment—it will represent the annual cost (except for operating losses, which are small with capacitors) of correction to any new power factor angle x. The general term will then be: Return x cost per kva. x demand x (tangent present p.f. angle b—tangent new p.f. angle x.)

Various new power factors were assumed up to 100 per cent and the angle x corresponding to them was substituted in the term above. For each value of percentage return used, a curve was plotted showing annual correction costs for various new power factors. The series of curves for the plant in question is shown in Figure 2. The annual savings for various power factors up to 100 per

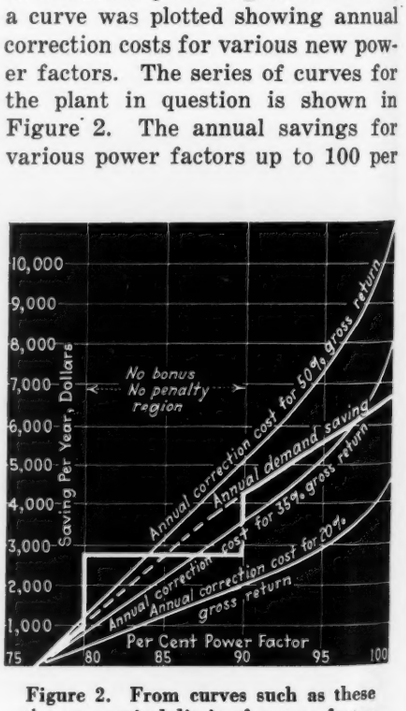


Figure 2. From curves such as these the economical limit of power factor correction can be determined

cent have been plotted on the same chart.

It is a comparatively simple matter with the chart, to ascertain just how much correction is economically justifiable. Note that the curve for correction cost for 50 per cent gross return never crosses the annual demand-saving curve. It is obvious, therefore, that no amount of correction will return 50 per cent. On the other hand, at 20 per cent gross return, correction to the limit or unity power factor is entirely justifiable. But let us say that a 35 per cent return is required. This curve crosses the demand-saving curve at a power factor of about 97 per cent.

Saving $6,000 a Year

It can be determined by a simple calculation that 1,140 kva. of capacity will accomplish this correction. The total installed cost will be $14.50 x 1,140 = $16,530. The chart indicates that power bills should be reduced by about $6,000 a year when the power factor has been improved to 97 per cent. At 35 per cent gross return, or paying the cost of installation in approximately three years, 1,140 kva. of capacity should effect the maximum possible saving.

It will be seen, therefore, that with power factor correction, a sizable saving may not be the maximum obtainable saving. Try plotting costs and savings that result from various degrees of correction. The curves help to put power factor correction in a different light.

Testing with the High-Speed Movie

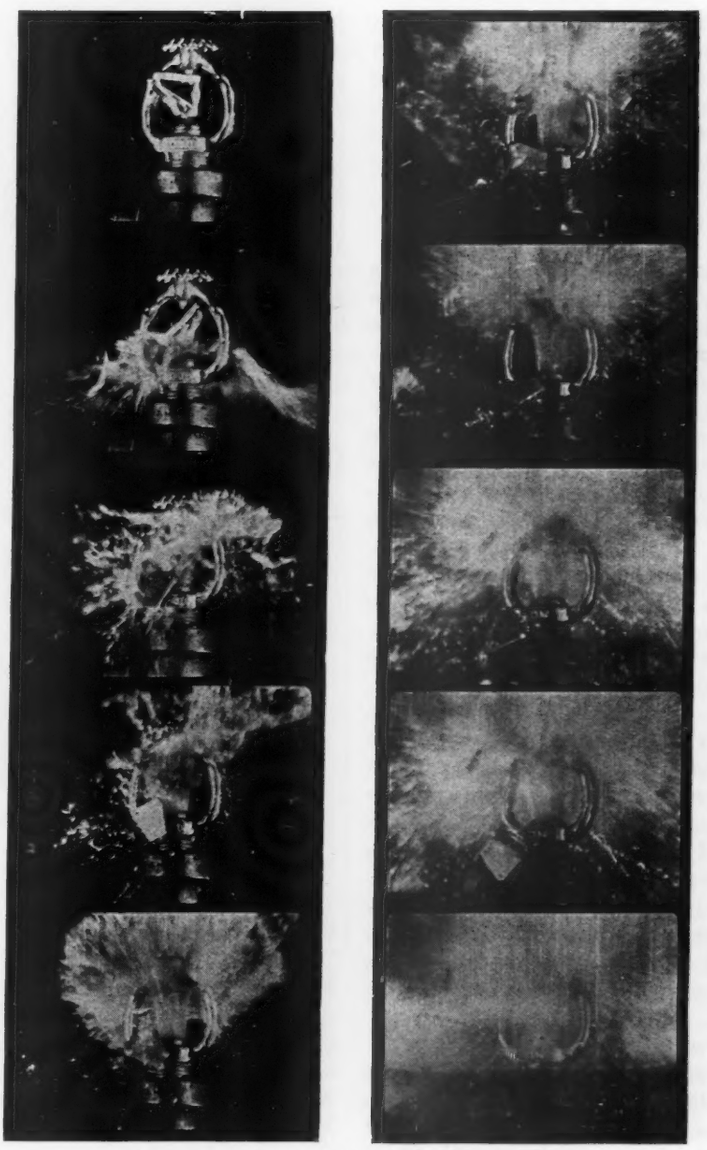
HIGH-SPEED movies are being used more and more by industry to check the performance of products, especially those with fast-moving parts. The method is to film the operation at, say, 192 frames per second, then study it in slow motion or frame by frame.

For example, the accompanying "stills," reproduced by permission of the Rockwood Sprinkler Company, Worcester, Mass., show what happens when a sprinkler head goes off. From them, company engineers learned things they often guessed at, but never could know for sure.

They learned that it takes just a tenth of a second from the time the heat strikes the solder until the water gushes forth.

Besides showing the speed with which the head operates, these films enabled the engineers to study the movement of parts and the distribution of the water. Parts which in reality flew too fast for the eye to follow, appeared on the screen to float tranquilly, thus affording ample opportunity for close study.

To be certain of product uniformity, five similar sprinklers were made to open successively before the camera and their operation studied. The more closely to observe the action of the parts, in three of these tests the water was shut off as quickly as possible after the head opened, so that the spray would not obstruct the operation of the moving members. In all cases the operation of these members of the figure 4 linkage was in the same sequence and in almost the identical manner.



Stills from one of the films showing what happens when a sprinkler head goes into action

Maintaining Belt Tension

In short-center drives is an important problem for which there are several solutions. What the solutions are; how they function

ROBERT W. DRAKE
Mechanical and Electrical Engineer
Indianapolis

IN APPLICATIONS of flat belts and V-belts to individually driven machines, the motor and driven pulleys are almost invariably so close together that sag in the belt cannot be depended upon to assure adequate belt grip on the pulley.

All leather, rubber, and fabric belts stretch — some more than others. If sag will not maintain belt tension when pulleys are close together, some other means must be substituted or belts must be taken up altogether too often in order to avoid objectionable slip.

Vertical Drive Preferred

Most experienced plant engineers prefer, when they can, to make drives from motor to driven machine vertical, not horizontal. There are many advantages in high mounting of driving motors on individually motored machines, but if motors are to be mounted high, many drives must be vertical or nearly so.

A vertical belt drive is difficult to keep tight. As the belt stretches, slack all collects at the lower pulley where it is most objectionable. No matter how great the distance between centers, sag cannot absorb the stretch.

To be sure, belts from countershafts to machines have been substantially vertical for 80 years. However, most belt drives from countershaft to machine can be so proportioned as to give ample pulley sizes, whereas on individually motored machines the universal desire to employ the cheaper, more efficient, higher-speed motors often results in a driving pulley that is undesirably small.

Thus in the typical drive from individual motor to machine there are combined three factors unfavorable to the most successful use of belt drives of the old type: (1) Short centers (pulleys close together); (2) vertical belt; (3) driving pulley likely to be rather small.

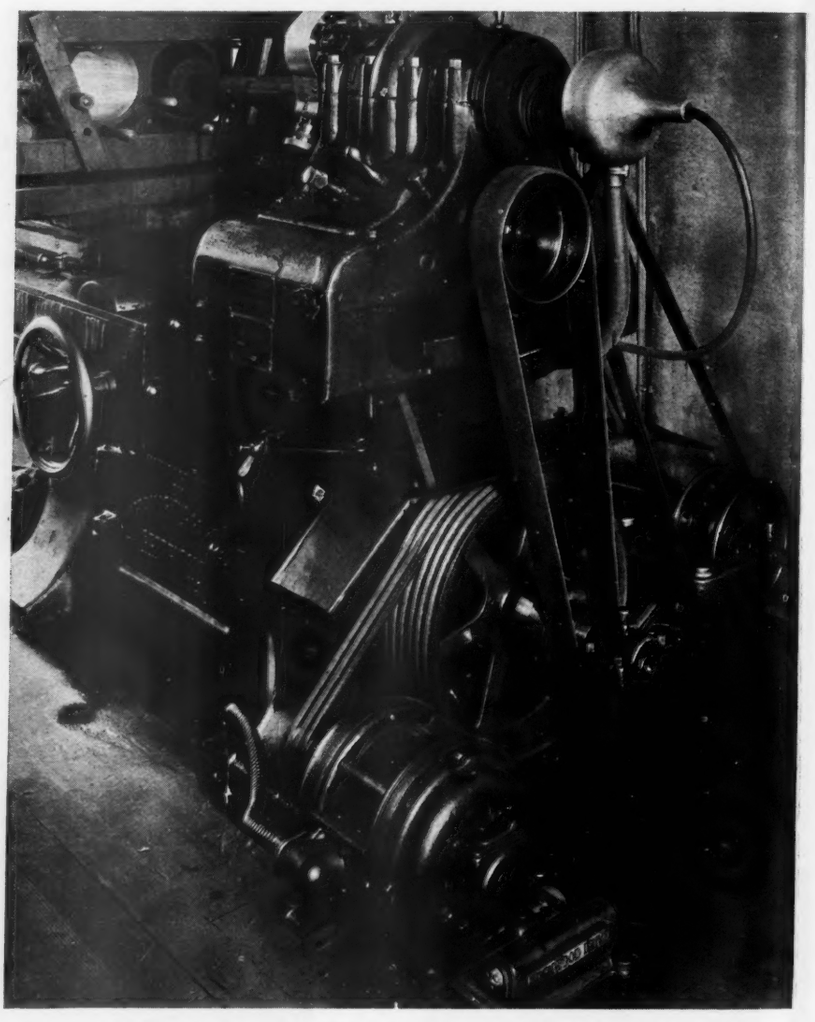


Figure 1. There's a place for both the V-belt and the flat belt on this cylinder grinding machine

Because of these limitations there has been a strong tendency to avoid belt drives on individually driven machines, although certain advantages of belting over the less elastic drives cause many plant engineers to use belting in spite of its shortcomings. For example, when something jams on a machine the belt usually comes off or breaks and often saves the machine. Belts smooth out vibration, shocks, and jars and prevent much "gear marking" and chatter of finished surfaces.

More important, the speed of a belt-driven machine can be changed quickly by changing a pulley. Only a production man knows how often such speed changes are desirable. Furthermore, a moderate stock of

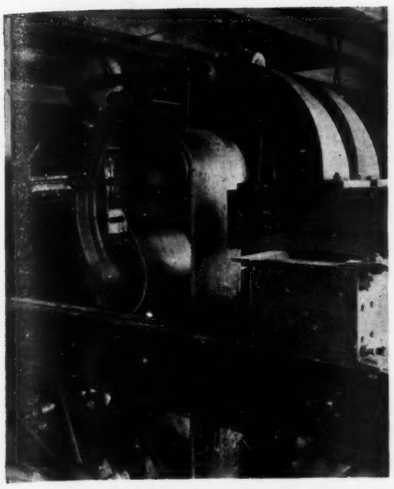


Figure 2. A good way to keep the required tension in a vertical belt drive is to use an idler pulley. This one is in a paper mill

replacement material serves for immediate repair or maintenance of a large variety of belt drives.

There has been, therefore, continuous pressure to improve short-center belt drives, dating from the large-scale introduction of individual drive into industry about 1900-1903.

Belt Pull Depends on Grip

Many means have been tried. A half dozen have proved worth while. To judge the effectiveness of the various improvements, we must consider on what the power transmitting capacity of a belt drive depends.

The power which a belt drive can transmit is determined first by the natural grip between the materials of which pulley and belt are made—the "coefficient of friction" of the two materials. For this reason a paper pulley will carry more load than a metal pulley with the same belt. A leather belt will pull more load than belts of most other materials. Leather tanned in one way will pull more load than leather tanned in another; leather run with the flesh side against the pulley will pull less load than when the grain side is against the pulley.

But no matter how good pulley and belt are in this respect, they will not pull their load unless a certain minimum pressure exists between belt and pulley surface. This pressure can be maintained only by keeping a corresponding tension in the belt. If a belt is made short, its elasticity will maintain this tension for a while, until it stretches. Some means must therefore be provided for maintaining tension.

The power a belt can transmit depends largely upon the belt speed. Within limits determined by the stiffness of the belt, by centrifugal force, etc., any belt will transmit more horsepower the faster it travels. The limits vary somewhat, but there is little to be gained by operating a flat belt above 4,000 feet per minute, or a rubber V-belt above 3,000 or at most 3,500 feet per minute unless, with the latter, both sheaves are of exceptionally large diameter for the size of belt used.

When Belt Stretch Is Reduced

It would seem, then, that the area of contact between belt and pulley is not of primary importance—that, other things being equal, a 4-in. belt will carry as much load as a 6-in. if the same total pressure be maintained between belt and pulley. That is true. We do not take more advantage of this fact because excessive belt tension leads to rapid and excessive belt stretch, frequent take-up, and short life.

Attempts to provide proper tension without frequent take-up have sought to decrease the amount and rapidity of belt stretch, to provide automatic means for taking up stretch, to increase the grip between belt and pulley so that less pressure is necessary.

Much progress has been made in increasing the grip between belt and pulley through the development of the paper pulley, improved tannage of leather belting, superior gripping surfaces on many rubber cord belts, as compared with the "friction" surface formerly used on rubber and fabric belts.

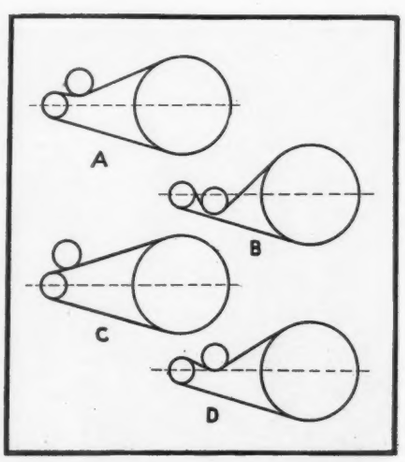


Figure 3. One correct, several incorrect, ways of installing an idler. With the idler in position *A* tension in the belt will be high; in position *B* it will be much lower. With the idler located as in *C* motor bearings and belt would probably fail quickly. Diagram *D* shows the correct position for the idler

In the direction of reduced stretch, progress has also been significant. Rubber V-belts, Figure 1, now stretch slowly, have a wedge shape that requires only one-third or one-fourth as much pressure between belt and pulley as did flat rubber belting. There is available double leather belting that stretches decidedly less than belting made by older methods.

Similarly, rubber belts are obtainable in which the tension is carried not by duck or canvas plies but by many cords, similar to those in a cord tire. A later development involves vulcanizing such belts with the cords under tension, so that much of the stretch is removed before they are put into service.

Less Attention Required

Experience has shown that a belt of good quality, liberally proportioned to the load, will stretch much more slowly than a narrower belt. By doubling the belt width without increasing the total tension, the stress per square inch of cross-section is halved and for drives with moderate belt speed the period between take-ups is increased around tenfold.

The tension in any belt at no load must be sufficient to assure grip at the moments of heaviest load, usually the starting period with belts driving individual machines. Therefore, to minimize stretch, a belt must be liberally designed, not only for the rated capacity of the motor, but also for the starting jerk and the still greater pull exerted by the motor as it accelerates to full speed. During this period the pull is 2½ to 3½ times the belt pull at full rated load.

Liberal proportioning of belt drives is not unduly expensive because the belts are usually short, and is satisfactory on the less severe drives. But it does not solve the problem in all cases. For a real solution some automatic means is required to maintain the desired belt tension in spite of stretch. Such a

device must take up the stretch for long periods without attention.

In the operation of paper machines, where successive sections of the machine are driven by belts from a common shaft, the elimination of belt slippage is particularly necessary, since variation in the relative speeds of the machine sections causes tears in the sheet of paper and consequent manufacturing delays.

Keeping Belts Tight

Necessity of reducing belt slippage led to the idea of using an idler pulley actuated by gravity, commonly used in the sawmill days in Maine and Michigan. This device, Figure 2, approaches the requirements stated above. It maintains sufficient tension to assure pulley grip through quite a range of belt stretch, and if combined with a motor mounted on a sliding base may well obviate the necessity of ever re-splicing the belt of a short-center drive.

The tension is, however, by no means unvarying. When the idler is in the position shown in Figure 3*A*, the tension in the belt is higher; when it is in the position shown in Figure 3*B*, the tension is decidedly lower. If an attempt were made to operate such a drive in a position about as shown in Figure 3*C*, the belt tension would be terrific, the motor bearings would immediately overheat, and the belt life would be very short.

In adjusting a new drive the motor should be moved until the belt takes the position shown in Figure 3*D*. Then the weight of the idler pulley or the auxiliary weight should be adjusted to carry the load without slipping, except possibly at starting or at extreme peaks, as the drive application may require. It is usually necessary in practice to reduce the weight until slip occurs, and then add a little. If the drive is loaded up enough to be "safe," twice as much weight as necessary will frequently be used. Then belt life will be greatly decreased as will bearing life on motor and driven machine.

The next development in suiting the belt to its job involved a change in the belt, rather than the addition of gadgets to keep it tight.

Once more it was the re-application of an old idea. Balata V-belts designed to run in V-grooved sheaves originally installed for rope drive had been in operation in Scotland since the turn of the century. Shortly afterward, leather V-belts found a limited use in this country. Now the V-belt principle was applied to rubber belting reinforced with cotton cords.

Like leather belting, such belts have very low stretch if moderately loaded, but if loaded too heavily the cords will not stand the strain and the belt stretches. Many drives are badly overloaded during starting or at load peaks, but in time it will be generally realized by users that many individual-drive belts must carry 200-300 per cent of full-load pull during the starting period (even 400 per cent and more in the case of single-phase motors below 5 horsepower).

Reducing Belt Slip

The wedging action of V-shaped belts in the grooves greatly reduces belt slip under normal drive conditions. The rubbing which they get when entering and leaving the grooves dislodges most of the dirt and dust. Above all, the advantage of this drive is that, although it may and in severe applications frequently does slip more than the best short-center flat-belt drives, the V-belts cannot come off, regardless of how much they slip. And when something jams and they do slip it is remarkable how little damage the slipping does.

No automatic feature for maintaining tension is included in this form of drive. With a liberally designed drive the stretch is slow and the wedging action is depended upon to give adequate pulley grip. Take-up, required more or less frequently, must be accomplished by increasing the pulley center distance, since the belts cannot be shortened.

Less Guesswork

Judging from its acceptance this drive is more generally applicable in industry than the idler drive, partly because its proponents have been more liberal with engineering information to help the customer design his drive rationally and avoid guesswork.

The principal limitation of the V-belt is the fact that the coefficient of friction or grip between pulley and sheave decreases steadily, due to a gradual hardening of the belt surface. In applications where there is considerable slip, the belt surface may glaze if periodic tightening of the drive is neglected.

Another limitation arises from the fact that at belt speeds above 3,000 to 3,500 feet per minute where one sheave is rather small, centrifugal force interferes with the wedge action and necessitates tighter opera-

(Continued on advertising page 54)

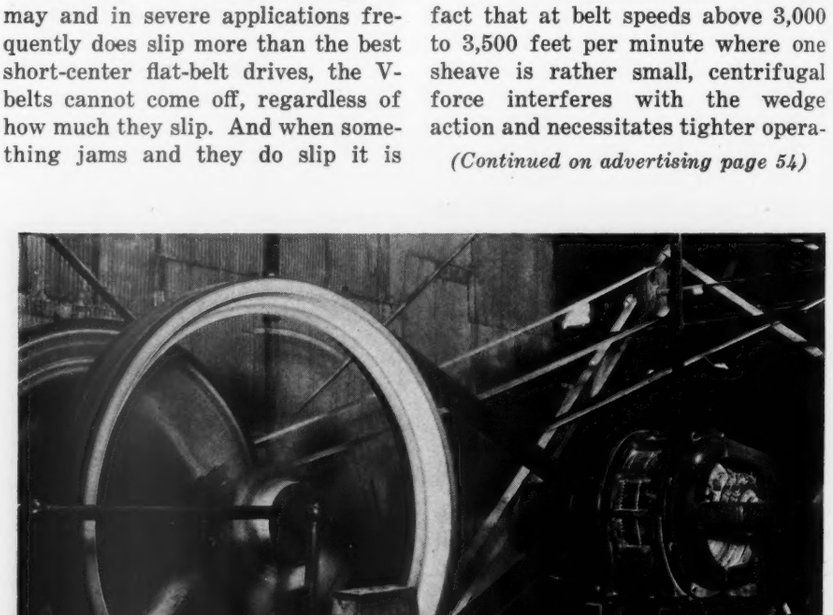


Figure 4. Another way to maintain belt tension is to make the belt support part of the weight of the motor. This principle underlies the pivoted motor base. The one shown is designed for horizontal applications

When and for How Long

Timing devices are the brains of control circuits; theirs the important task of starting, stopping, directing

L. E. MARKLE

Industrial Control Engineer
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

FREQUENTLY some form of timing device is essential to the satisfactory solution of a control problem. Each installation will have special requirements that determine the type of timer needed. Some will require merely the measurement of a certain period of time, whereas others will require the repetition of certain definite time cycles at predetermined intervals.

There Are Several Types

Regardless of the timing periods involved, there are certain characteristics that may make one type of timer more desirable than another. In the accompanying table the more common types of timing devices have been listed, and an attempt has been made to show the outstanding characteristics usually found in each type. Since many of the terms used in this table are relative only, and because many installations will have requirements that immediately preclude the use of certain types of timers, the chief value of the tabulation lies in the comparison of the characteristics of the different types of timing devices.

For Complicated Circuits

A typical form of motor-driven drum, which is one of the oldest types of timing devices, is illustrated in Figure 1. Usually a fractional horsepower motor is geared to a drum. The number of circuits depends on the length of the drum.

On such units the sequence of circuits can be made to meet practically any conditions. The multiple-circuit and circuit-sequence features of the motor-driven drum are outstanding, and are not possessed by other devices. The timing depends upon the motor speed and the gear ratio and is not readily adjustable, especially on a.c. installations, except by change of motor or gear ratio.

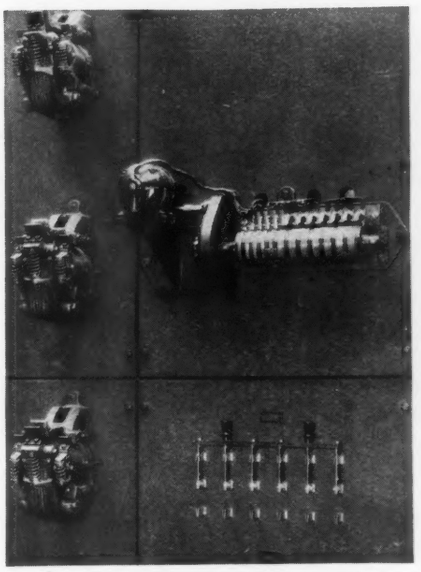


Figure 1. The motor-driven timing drum is one of the oldest and most flexible of timing devices

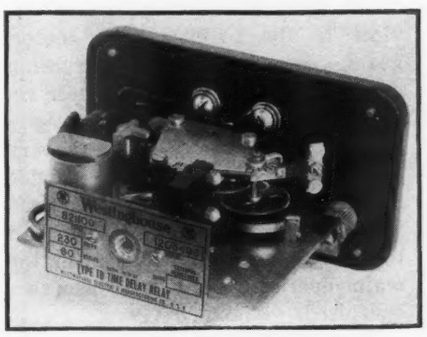


Figure 2. Motor-driven relays are often used for timing operations where space for the timer is limited

Since motor failures are not frequent, the motor-driven drum may be considered quite reliable in operation. It is, however, somewhat expensive and usually occupies considerable space; therefore, it is most frequently used on installations where complicated circuits must be controlled in definite sequence and operation without interruption is absolutely necessary.

After a timing sequence has started or has been completed, the time required to reset the device in readiness for the next cycle or period is important. Since motor-driven drums usually operate at relatively low drum speeds, these devices are not of the quick resetting type. The circuits are usually arranged so that, if for any reason a starting sequence is interrupted before it is completed, the motor-driven drum must be in the off or starting position before the main motor can be restarted.

For Simple Timing Sequences

Motor-driven relays are distinguished from motor-driven drums by the fact that very small induction or self-starting synchronous motors are used, and the device is capable of handling only one or two circuits. As indicated by Figure 2, these devices are compact and often built to be inclosed in small metal or glass cases.

Usually a contact arm is driven by the motor through a set of gears against a stationary contact and held there during the normal operating period by the stalled motor. The time obtained is that required from the instant the motor starts until the moving contacts are driven against the stationary ones. The time delay is adjusted by changing the distance through which the contact arm must move before it strikes the stationary contacts. Quick reset for the next operation is usually provided.

Devices of this kind are reliable, but the motor and operating mechanism make them rather expensive. These relays are used where the circuits are few and the timing

Characteristics of Control Timing Devices

	Adjustable Time Period	Cost	Compact	Quick Reset	Circuits
Motor-driven drum	Seldom	High	Seldom	Seldom	Many
Motor-driven relay	Yes	High	Yes	Yes	Few
Time clocks	Yes	High	Yes	Seldom	Few
Geared relays	Yes	Moderate	Yes	Yes	Few
Escapement relays	Yes	Moderate	Yes	Yes	Few
Dashpots	Yes	Moderate	Yes	Yes	Few
Magnetic timers	Yes	Low	Yes	Yes	Few

sequence is comparatively simple.

Spring-wound or motor-driven timing clocks are becoming quite popular. The motor is either of the induction or self-starting synchronous type. Timing clocks are very well adapted for use on applications where a timing cycle is repeated, as on a mixing process where power is applied for some minutes for mixing, removed to allow dumping and refilling, and then applied again for mixing. Also, they are very useful for controlling airplane beacon lights in remote locations.

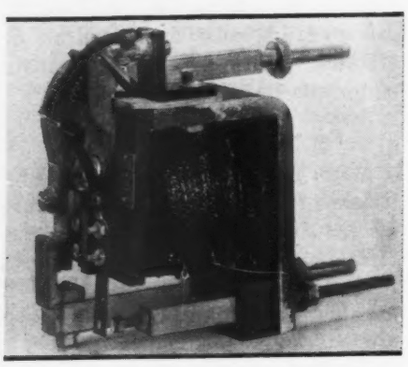


Figure 3. Magnetic timers are rugged, use no gearing, and can handle considerable current

Time clocks are reliable in operation, compact, and adjustable within limits for different time cycles.

Geared and escapement relays resemble each other in that some magnetic action is usually used to store energy which is later dissipated through gears or a clock escapement to provide a desired time delay. These devices are made adjustable and although they are somewhat sensitive to the effects of friction, their cost is attractive enough to assure their continued use.

These relays are applied where few circuits are involved and the timing sequence is simple.

Dashpots, like motor-driven drums, are among the first designs of timing devices. They are either of the air or oil type, although the oil types are the more common.

In most designs a magnetic force is applied to move a plunger, whose motion is restrained by the action of the dashpot, thereby creating a time delay. The time is usually adjusted by opening or closing the holes or ports through which the oil or air passes as the plunger moves. Careful alignment of parts and absence of excessive friction are essential to the operation of dashpots. Unless a specially prepared oil is used, the time obtained will vary with the viscosity of the oil as temperature changes occur. Dashpots are used where only a few circuits are involved and the timing sequence is not complicated.

For D.C. Circuits

Magnetic timing contactors, Figure 3, are of rather recent design. They differ from most other timing devices in the absence of a motor, gears, escapement, or restraining device such as a dashpot. These relays resemble ordinary magnetic contactors or relays. They have very good magnetic circuits and provide delay because of the time required for the flux in the magnetic circuit to decrease to a low value after the main operating coil has been deenergized.

Magnetic timing contactors can be used only with d.c. magnetic circuits, although they may be used on a.c. circuits if a rectifier is provided to furnish direct current for the operating coil.

In contrast to many timing devices, magnetic time contactors are designed to carry heavy currents rather than light control circuits. They are well adapted for accelerating motors because the timing feature and the accelerating contact for each point are combined in one unit. These units are very rugged in design, compact, and low in cost. The time delay can be varied from ½ second to about 10 seconds. In addition to the main contacts they usually have one or more auxiliary or control contacts.

•

$1,500,000,000 for Repairs—Right Now

INDUSTRY will spend $1,500,000,000 immediately for plant betterment. That is the prediction made February 14 by James A. Moffett, Federal Housing Administrator.

There is an "if." It is, *if* Congress approves proposed changes in the Housing Act. The changes would make it possible for the FHA to guarantee industrial loans up to $50,000 for this purpose.

Administrator Moffett's prediction is based on replies to questionnaires that were sent to 22,000 of the country's 147,000 plants. The replies showed that industrial concerns were ready to spend money for machinery replacements and plant repairs, but preferred to do it through their own banks instead of some government agency like the RFC.

To Start the Ball Rolling

Administration leaders, including Donald R. Richberg, director of the National Emergency Council, have long held that the making of machinery and plant replacements would greatly spur recovery. This is the first time, however, that they have received confirmation of their view that industry recognized the need for making such replacements.

So far, indications were that the government would not suffer a loss of more than 3 to 5 per cent on the home renovation program, Mr. Moffett said, which meant that there would be ample funds to finance the factory renovation program "where the margin of loss will probably be greater."

If the FHA were permitted to guarantee loans up to 20 per cent (as in bank loans for home repairs), it should be able to make guarantees up to $1,500,000,000 and thus set the ball rolling for further replacements. Confirmation from industry that it would borrow will help the cause.

A.C. Wave Windings

A new and less complicated type of connection diagram simplifies the job of laying out and connecting

A. C. ROE

DIAGRAMS heretofore used to show the lead locations, coil pitch, line or ring connections, coil grouping, short pitch grouping, and so on for a.c. stator or rotor windings of the wave type have been complicated and cumbersome because of the amount of data and the method of presenting it. Largely for this reason there has been no attempt to publish complete connecting diagrams and grouping charts, as has been done with connecting diagrams for a.c. lap windings.

Since there is need for a discussion of a.c. wave windings, illustrated with simple, clear, connecting diagrams, a thorough study of the subject was made and resulted in a new method of presentation that eliminates the disadvantages referred to above.

The diagrams that will be used in a series of articles on a.c. wave winding connections, of which this is the first, are based on the fact that for the same number of slots per pole per phase the coil pitches are the same, regardless of the number of poles. Therefore, one diagram can be made to cover all slot and pole combinations which, when divided by the total number of pole-phase groups, results in the same number of slots per pole per phase.

Phase Connections Are Grouped

A second basic principle of the new diagrams is that at three points on the winding, usually spaced 120 degrees apart, all the lead connections for each phase are grouped together, as Figure 1 shows.

The group or phase section shown in Figure 1 consists of four leads—two top leads marked *A3* and *A4*, and two bottom leads marked *A1* and *A**. Between leads (*A1* and *A3*) and (*A** and *A4*) are two figure-8 connecting clips that join together the short pitch, *SP-1* and *SP-2* leads.

Thus, in each of the three sections there are grouped within a short radius all of the important connections for one phase. When these are located and marked the rest of the connecting process is simple.

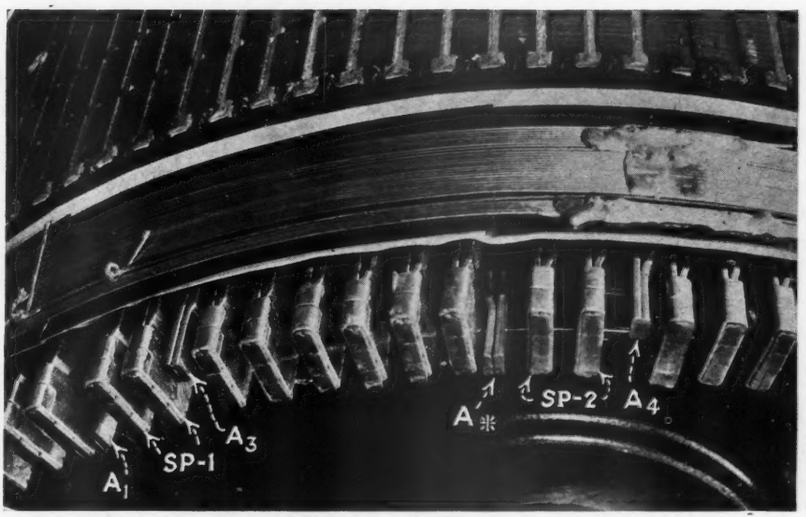


Figure 1. Top and bottom leads of A-phase group in a winding that has three slots per pole per phase

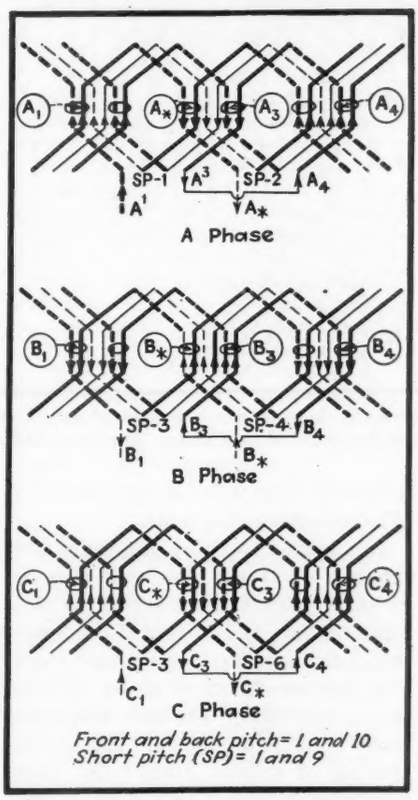


Figure 2. Simplified connecting diagram for the three phases of the winding shown in Figure 1. The heavy lines indicate phase insulation

By making a small diagram of the coil and lead layout of each phase-lead-group section and arranging the three diagrams together one above the other, a clear, small connecting diagram is produced.

Tables Supplement Diagrams

Figure 2 shows the small, layout diagram for the winding shown in Figure 1. Note that a small circle is used to inclose the top and bottom conductors in the same slot. Also, that the location of the slot containing a lead is indicated by inclosing the lead symbol in a small circle and connecting it by an arrow to the proper slot.

In conjunction with the diagram shown in Figure 2 a table can be used to give the slot number of each lead, for any number of slot and pole combinations that give three slots per pole per phase.

Another table can be prepared to show the possible line connections such as series star, parallel star, series delta, and parallel delta, so

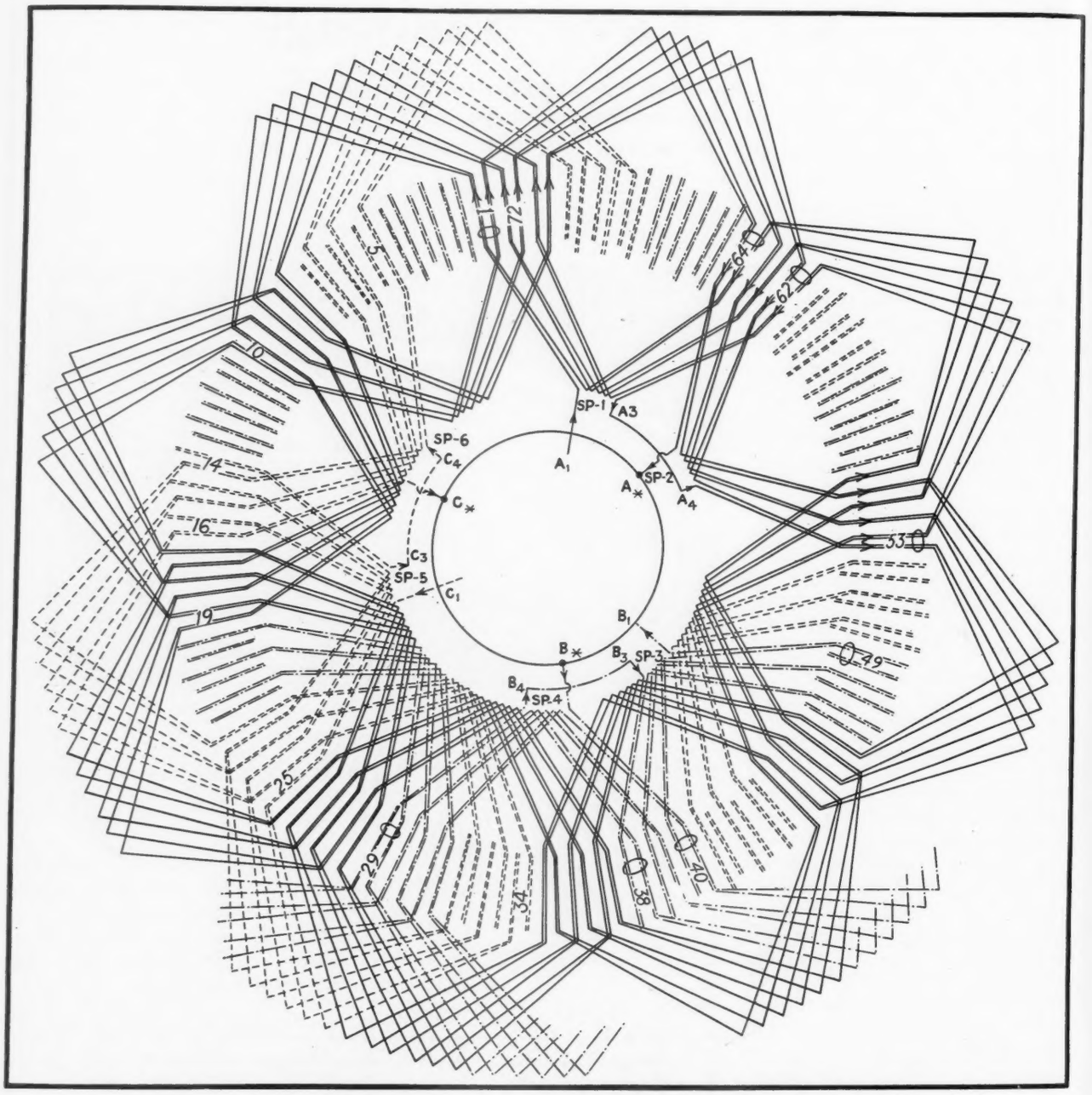


Figure. 3 Conventional diagram showing one complete phase of an eight-pole, three-phase, 72-slot winding having three slots per pole per phase. The front and back pitches are 1 and 10

that each small diagram can be used for the four connections that are possible.

The diagrams to be presented in this series will cover 2, 2½, 3 3½, 4, 4½, 5, 5½, 6, 6½, 7, 7½, and 8 slots per pole per phase, and will require thirteen small, simple diagrams of the type shown in Figure 2. A table will give the number of each slot per pole per phase-group for 4 to 24 poles, inclusive. In other words, for each slot per pole per phase-group there will be the equivalent of 44 connecting diagrams, so that the total coverage will be equivalent to 572 connecting diagrams.

In addition to these diagrams and tables a checking table will also be given to permit the addition of slot combinations and to enable the spacing of the groups to be changed from 120 degrees apart to closer grouping, if required. The new diagrams have been laid out for 120-degree spacing of groups, since most wave windings are used on rotors having this spacing.

The size and complexity of the new and old types of diagram can be compared from Figures 2 and 3. Figure 3 represents a 72-slot, 8-pole, three-phase winding, having three slots per pole per phase. To simplify the diagram in Figure 3 only one phase has been shown complete, but each phase-group is indicated. If the three groups of lead groupings are arranged as in Figure 2 the same results will be obtained with less confusion and in considerably less space.

(A succeeding article, to appear in an early issue, will give the master table and line connection chart. Ed.)

Questions *and* Answers

Conducted by G. A. VAN BRUNT

40-Cycle Devices on 60 Cycles

I should like to know (1) Whether it will be possible to use 550-volt, three-phase, 40-cycle compensators on a 550-volt, three-phase, 60-cycle circuit; (2) what trouble, if any, would result from using 550/110-volt, 40-cycle, single-phase transformers on a 60-cycle, 550-volt circuit; (3) can 40-cycle circuit breakers and magnetic switches be used on 60 cycles; (4) will the losses in single-phase, power transformers be increased very much at loads ranging from 25 to 75 or 80 per cent of rating?
H.F.—Boston

THE AUTO-TRANSFORMER of compensators will usually operate satisfactorily when used on higher frequency circuits, as when changing from 40 cycles to 60 cycles. It may be necessary, however, to change all voltage coils since they may not hold satisfactorily.

No particular trouble will be experienced in operating a 40-cycle transformer on 60 cycles except that it cannot operate at full capacity and maximum efficiency. In order to maintain normal operating conditions the voltage should be changed by the same proportion and in the same direction as the frequency change. Since this cannot usually be accomplished, the coils of the transformer would have to be rewound.

A 40-cycle circuit breaker can be used on 60 cycles, provided the coils are changed for 60-cycle operation and the load current does not exceed the present rating.

The efficiency of most power transformers is practically constant from ⅛ to 1¼ load.
P. LINDHOLM
Newark, N. J.

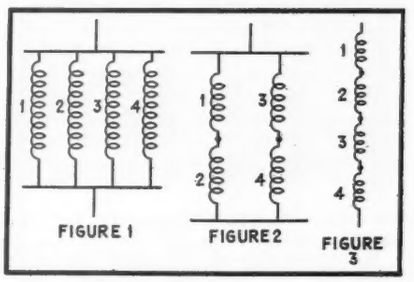
From 220 to 440 Volts

I should like to know the best way to change a 20-hp., three-phase, 60-cycle, 220-volt squirrel-cage motor for operation on 440-volts, same number of phases, frequency, and speed. This motor has eight poles, 96 coils. Will this change affect the power factor or efficiency in any way?
E.D.—Chattanooga, Tenn.

IF THE motor is now connected two-circuit, either star or delta, it can be operated on 440 volts and retain its normal operating characteristics by reconnecting the coils for series, or single, star or delta. Whatever the present connection, in order to double the operating voltage the number of coils in series must be doubled.

Assuming that a series connection is now used, it will be necessary to rewind the motor. To do this, the area in circular mils of the present wire will have to be determined and a wire having one-half the circular mil area selected for the new winding. The new coils should have twice the number of turns used in the old winding.
M. V. MILLER, *Indianapolis*

THE QUESTION does not state how the coils in the pole groups are connected, or whether the phases are connected in delta or wye. Since there are 96 coils the indication is that there are four coils per pole group for each of the eight poles. Assuming that these four coils are connected in parallel, as in Figure 1, the coils in each pole group can be reconnected series parallel, Figure 2, being careful to maintain the proper polarity. This reconnection would in no way alter the rating of the motor since the coils have simply been reconnected for double the voltage and half the current formerly carried.



If the coils are now connected in series parallel, Figure 2, they can be reconnected in series for each pole group, as in Figure 3.

No other connections need be changed.
W. T. TAGGART
Harrisburg, Pa.

?

What are your most troublesome problems? Free-for-all discussion of them will help you and other readers

Answers Wanted

How Splice Resistance Wire?

Can someone tell me whether, or how, Nichrome resistance wires can be joined together? Quite frequently I want to splice two pieces of such wire, or put on taps, but I have found no satisfactory way of doing it. The temperature of the wire will not exceed 1,000 deg. F. *F.H.—Albert, W. Va.*

Combustion Control Instruments

I should like to have the opinion of readers as to how large a boiler plant must be, based, say, on the rated horsepower of the boilers, before the installation of such instruments as steam flow meters, CO_2 gages, flue temperature indicators, and so on, can be justified. That is, what must be the rating, as a rule, before the savings possible by the use of these instruments would probably pay a good return on the investment? Will you also give me in the order of their importance the three boiler plant instruments that are most valuable, or whose use is likely to lead to the largest savings?
L.O.K.—Cincinnati

Frost Forms on Commutator

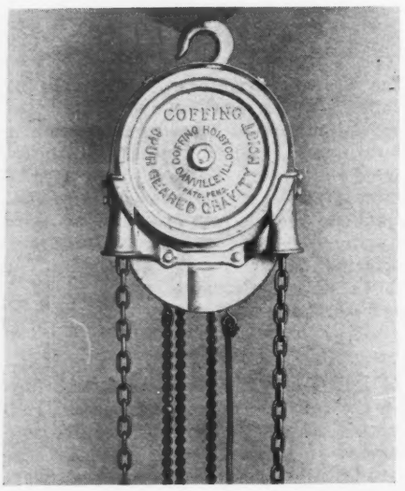
We are having trouble with frost forming on the control board and commutator of the hoist motor on our coal bridge, after it has been idle for some time. I should like to know from the experience of other readers whether there is any better way of removing it than by the use of a blowtorch. What is the best way to prevent its formation? *H.J.E.—Duluth, Minn.*

D.C. Generator Brushes Chatter

A 150-hp. d.c. generator is giving much trouble from constant chattering of the brushes. By putting a little paraffin on the commutator we can stop the noise for about an hour, but it always returns. The commutator has been turned down, but that did not help. Then the brush-holders were reversed so that the brushes point in the direction of rotation instead of against it, as formerly, but there was no improvement. Would the clearance distance be-

(Continued on advertising page 62)

EQUIPMENT NEWS



Hoist

Gravity-type, spur-gear, ball-bearing. Manufacturer claims high speed, free chain, quick adjustment, light weight, load chain that will not tangle. Release clutch, operated by pulling rope, permits load to be lowered at any speed, stopped in any position. Made in ½-, 1- and 2-ton sizes. One-man operated. Coffing Hoist Co., Danville, Ill.

Air Filter

Hollow candle of diatomaceous earth contained in chromium-plated case. Air forced from outside of candle to center. Petcock drains water, oil, and scale from bottom of shell. Pressure drop, 5 to 7 lb. Porosity can be controlled. Two sizes, capacities 8 and 16 cu.ft. per minute, both with ¼-in. pipe connection. Large size 16 in. long by 3½ in. outside diameter. Candle walls for large size candle, ¾ in. thick. Filter cleaned by removing candle and sanding outer surface. Clean Air Filter Co., 1440 Broadway, New York.

Steam Connection

Flexible, seamless tubing with brass bracket support. Tubing of special bronze with deep helical corrugations for flexibility. Bracket holds tubing in horizontal position to prevent sagging and formation of water pockets. American Brass Co., Waterbury, Conn.

Globe

Vaporproof reflector. For chemical plants, distilleries, and breweries, where corrosive fumes or moisture would corrode sockets of ordinary fixtures, and where excessive dust and fumes make cleaning difficult. Smooth inside and outside surfaces. Distribution curve between 40 and 50 deg. Called No. 02368. Holophane Co., Inc., 342 Madison Ave., New York.

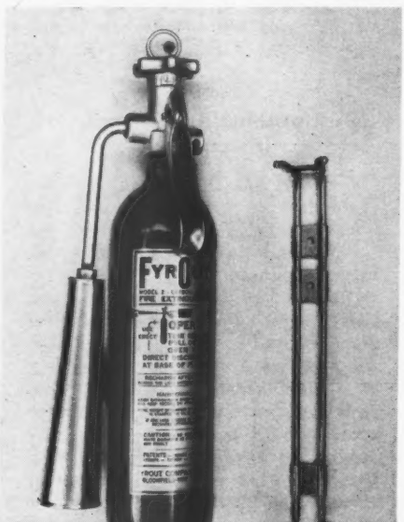
Lamp Bracket

For machines. Steel. Three ball-and-socket joints enable operator to place light in any position. Cord contained in bracket. Aluminum shade gives protection to lamp. Bulb can be changed without removing shade. Fostoria Pressed Steel Corp., Fostoria, Ohio.

Oil Seal

For high-speed shafts. With or without flange. Sizes from ¼ to 4 in. diameter. For horizontal and vertical shafts, worm gear reduction units, and electric motors. Consists of housing, diaphragm, and bronze seal ring. Compression springs in housing hold seal ring in tension with contacting face of ball race. Seals have ⅛- to $\frac{3}{16}$-in. movement to take care of wear and play of shaft. Heat resisting to 220 deg. F. constant, 275 deg. F. intermittent. Gits Bros. Mfg. Co., 1846 S. Kilbourn Ave., Chicago.

Fire Extinguisher



Weighs 10¾ lb. Carbon dioxide. Needs no recharging until used. Greater effectiveness claimed because of horn-shaped nozzle. Over-all length, 16¾ in.; diameter, 3½ in. Chromium finish. Called "Fyrout Model Two." Walter Kidde & Co., Bloomfield, N. J.

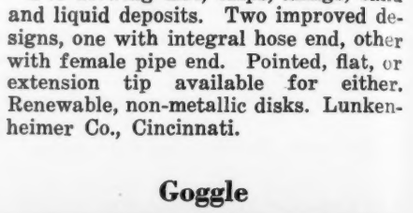
Material

Plastic. Manufacturer claims it can be molded into any shape, resists action of various chemicals injurious to rubber, possesses greater flexing life than rubber. Known as "Koroseal." The B. F. Goodrich Co., Akron.

Air Nozzles

For blowing dirt, chips, filings, sand and liquid deposits. Two improved designs, one with integral hose end, other with female pipe end. Pointed, flat, or extension tip available for either. Renewable, non-metallic disks. Lunkenheimer Co., Cincinnati.

Goggle



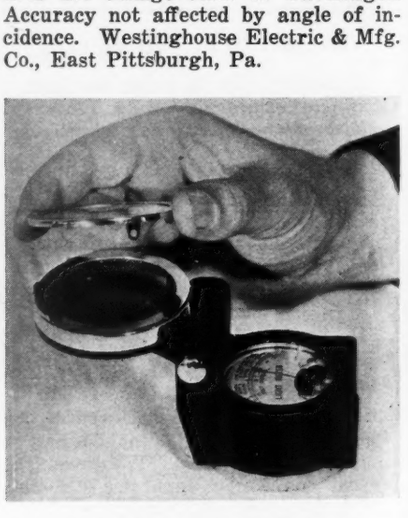
For work where temperature or humidity is high. Ventilation claimed sufficient to keep eye areas cool, lenses free from perspiration, steam, and fogging. Super Armorplate lenses. Called "Duralite—50 Hot Workers' Goggle." American Optical Co., Southbridge, Mass.

Motors

Squirrel-cage and slipring induction types. Convertible from open-type to fan-cooled, splash-proof or totally inclosed construction. Sizes from ½ hp., 600 r.p.m., to 125 hp., 3,600 r.p.m.; 110 to 220 volts. Rigidity attained by stacking stator laminations between heavy steel end rings and welding entire assembly to frame. Rotor windings assembled from hard drawn copper bars placed in rotor slots without insulation or slot wedges. Ends of bars brazed to end rings. Harnischfeger Corp., Milwaukee.

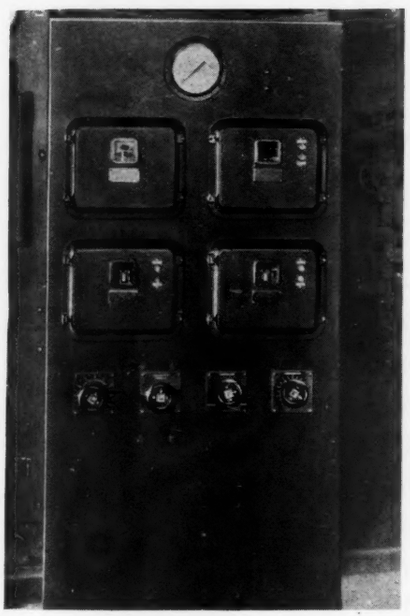
Range Multiplier

For light meter. Translucent screen clamped in front of exposed surface of photo cell increases instrument's range ten times by absorbing nine-tenths of light while transmitting remaining ten per cent. Manufacturer claims screen does not change color or wavelength. Accuracy not affected by angle of incidence. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



Combustion Control

Unit-constructed, ready for installation. Individual metering action for control of fuel feed, air flow, and furnace pressure. Controller at each boiler is mechanical balance with only one moving element. Master controller connects to all boilers and balances steam pressure against air-loading pressure. All control wires contained in one conduit connecting panel and individual drive units. Fuel-air rheostat, load-adjustment valve, transfer valve, and selector switch included on panel. For both large and small boiler units. Manufacturer claims device maintains air-loading pressure in definite relation to steam demand and balances against this pressure metered supplies of fuel and air to each boiler. Called "Metermax Unit Combustion Control." Leeds & Northrup Co., Philadelphia.



Timer

Automatic, double-pole, 20-amp., 120-volt, a.c. Called Series 75. Size, 2⅛x2½x2⅞ in. Dial diameter, 3¼ in. Panel opening required, 2½ in. diameter. Silver contact switch. May be used single-pole by bridging load contact. Dial timing range from 15 min. minimum, with 15-sec. graduations, to 120-min. maximum. Walser Automatic Timer Co., Chrysler Bldg., New York.

Tractor

Called "Silver King." Hercules, 4-cylinder, 20-hp. motor. Four speeds forward up to 14 miles per hour, one speed reverse. Wheelbase, 47 in. Can turn in 7½ ft. Weight, 2,600 lb.; drawbar pull, 2,600 lb. Automotive-type transmission. Force-feed lubrication, generator and starter, automotive-type muffler, swinging draw-bar hitch, bumpers front and rear, electric horn, foot accelerator, cushioned seat. Overall length 99½ in.; width 48 in.; height 55 in. Heavy-duty pneumatic tires. Fate-Root-Heath Co., Plymouth, Ohio.

Solderless Lug

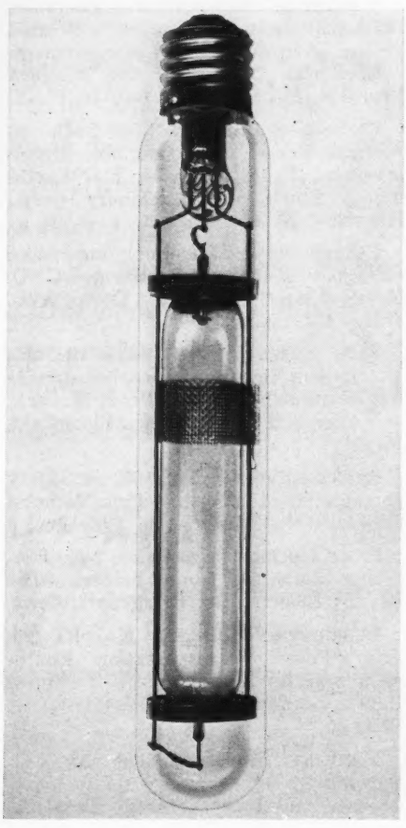
Triangular clamping arrangement forces stranded wires into solid mesh. Set-screw does not come into contact with wire. Serrated piece helps to hold wire securely. Various sizes, styles. For either solid or stranded wire. Deeper collars to hold more than one wire can be had. Ilsco Copper Tube and Products, Inc., 5629 Madison Rd., Cincinnati.

Grinders

Bench and pedestal grinders, combination grinder-buffers. Split-phase, condenser-type, 3-phase, or d.c. motors from ⅛ to 1½ hp., 110 and 220 volts. Totally inclosed motors mounted on sealed ball bearings and balanced to eliminate vibration. Skilsaw, Inc., Chicago.

Lamp

Mercury-vapor. High-intensity. Gives white light. Suited for high-bay lighting. Life of 1,500 hours; 110- and 220-volt, 60-cycle circuits. Claimed to produce 14,000 lumens at consumption of 400 watts. Length, 13 in. Vertical mounting. General Electric Vapor Lamp Co., Hoboken, N. J.



Grinder

High-speed, portable. Rated 50,000 r.p.m. Develops ¼ hp. Weighs less than 2 lb. Jigs and fixtures available to adapt it to milling, circular filing, reaming, routing, carving. Can be mounted in drill press to punch out small holes. Automatic lubrication. Onsrud Machine Works, 3900 Palmer St., Chicago.

Steam Conduit

Called "Therm-O-Tile." Underground steam conduit system. Simplicity of installation, durability, and high thermal efficiency (90 per cent or better), claimed by makers. Piping and conduit rest independently of each other on concrete base 4 in. thick. Bottom tile section rests directly on base and supports top tile envelope. Center drain in base carries off seepage or pipe leakage. Clay tile sections are double thickness with integral air spaces. Claimed waterproof under ordinary soil conditions. H. W. Porter & Co., Inc., Newark, N. J.

Clamps

Miniature "C." Called "Pony." Depth of throat, 1 in.; opening, 1 and 2 in. Malleable iron frame, foot ground smoothly and cadmium plated. Steel screws have standard threads, are tipped with swivels. Loose-pin handle gives ample pressure without resorting to pliers, yet permits closing in close quarters. Adjustable Clamp Co., 417 N. Ashland Ave., Chicago.

Fire Alarm

Called "Telafire." Mercury contact type. For use with electrical alarm systems. Operates at 135 deg. F. Can be supplied for either open- or closed-circuit use. Heat releases movable arm carrying mercury tube; one end of arm drops to make contact. Tube protects contacts from corrosion and

dirt. Any number of units can be connected on one alarm circuit. Available for battery or 110-volt, 60-cycle operation. Diameter, 3 in. Finished in red enamel. G-M Laboratories, Inc., 1731 Belmont Ave., Chicago.

Light

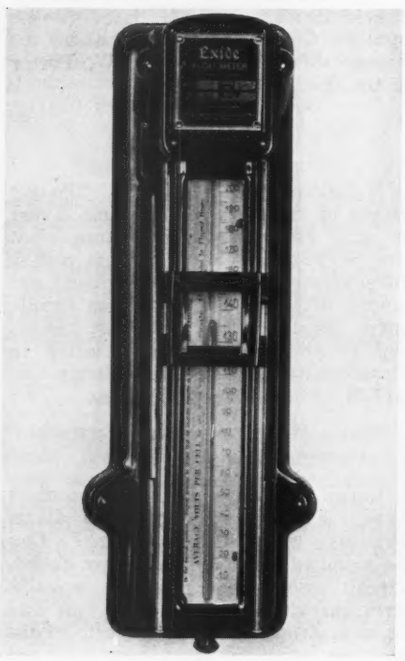
For barrel and drum inspection. Electric, vaporproof, portable. Can be put through bungholes 2¼ in. in diameter. Over-all length of lamp and handle, 30 in. Lamp protected by slotted brass guard. Weatherproof Bakelite socket. Takes 25-watt lamp. Pyle-National Co., Chicago.

Meter

Universal. Designed to measure any fluid under any industrial condition. Can be used for recording pressure compensation or correlated temperature, pressure, and flow. Flow rangeability ten to one. Charts have uniform graduations. Temperature and pressure records may be recorded on same chart with flow. When multiple-pen recorder is furnished, all pens move about same center of rotation, will not interfere with each other at any point in travel. Mechanical integrator shows total flow on counter. No multipliers necessary, counter reads directly in terms of total flow. Can be furnished with transparent indicating scale for reading flow at a glance. The Foxboro Co., Foxboro, Mass.

Meter

"Exide Float." For determining average voltage of battery or d.c. circuit over definite period of time. Operates on principle of electrolytic ampere hour meter. Draws current of 0.004 to 0.010 ampere. Accuracy claimed, 0.25 per cent. Electric Storage Battery Co., Philadelphia.



TRADE LITERATURE

•

BAKELITE—Booklet, "Bakelite Varnish, Enamel, Lacquer and Cement, Heat, Hardenable." — Bakelite Corp., Bound Brook, N. J.

BATTERIES—Bulletin, on the use of storage battery power.—Edison Storage Battery Division, Thomas A. Edison, Inc., West Orange, N. J.

BEARINGS—Bulletin No. 197, showing applications of ball bearings. — The Fafnir Bearing Co., New Britain, Conn.

CHAIN DRIVES—Booklet, highly illustrated, on silent and roller chain drives.—Morse Chain Co., Ithaca, N. Y.

CHAINS—Bulletin No. 74, on chains, sprockets and buckets.—C. O. Bartlett & Snow Co., Cleveland.

COMPRESSORS—Bulletin L-611-B3, on steam booster compressors.—Worthington Pump and Machinery Co., Harrison, N. J.

CREOSOTE—Booklet on "Preservation With NO-D-K Natural Wood Creosote." —Tennessee Eastman Corp., Kingsport, Tenn.

DRAWN STEEL—Pamphlet on cold-drawn steel.—Union Drawn Steel Co., Massillon, Ohio.

ELECTRICAL EQUIPMENT — Pamphlet calling attention to economies effected by use of modern electrical equipment. —Electrical League of the Niagara Frontier, 210 Pearl St., Buffalo, N. Y.

ENGINES — Bulletin S-500-B6D, on vertical 4-cycle diesel engines, direct-injection, Types B, C, D, E.—Worthington Pump and Machinery Corp., Harrison, N. J.

EQUIPMENT — Catalogue, anouncing all types of metal equipment.—L. O. Koven & Brother, Inc., 154 Ogden Ave., Jersey City, N. J.

FIRE EXTINGUISHER—Form AD455, announcing lightweight carbon-dioxide fire extinguisher called Fyrout Model 2. —Walter Kidde & Co., Inc., Bloomfield, N. J.

LAMPS—Bulletin No. 190, on safety portable hand lamps. — Pyle-National Co., 1334 N. Kostner Ave., Chicago.

LAMP HOLDERS—Catalogue page 8-A, listing Lumiline lamp holders.—The Bryant Electric Co., Bridgeport, Conn.

LUBRICATION—Bulletin No. PT-124, title "Power Transportation Equipment and Its Lubrication."—Technical Dept., Standard Oil Co. (Indiana), Chicago.

MACHINE BASES—Leaflet No. 41, showing designs and costs of arc-welded rolled-steel bases for machinery. — The Lincoln Electric Co., Cleveland.

METER—Pamphlet, title "The Exide Float Meter."—The Electric Storage Battery Co., Philadelphia.

METER ACCESSORIES—Leaflet, showing electric meter devices. Chart inspector, portable transformers, connectors, pen filler, counters, meter ink, clamps, meter transporting cases.—The Esterline-Angus Co., Indianapolis.

MOTORS—Bulletins No. 507, 510, and 514, describing d.c., totally inclosed fan-cooled, and single-phase capacitor motors, respectively.—The Louis Allis Co., Milwaukee.

OIL SEALS — Pamphlet describing metal diaphragm seals for high-speed shafts.—Gits Bros. Mfg. Co., 1846 S. Kilbourn Ave., Chicago.

PAINTING—Booklet on the use of painting in plant conditioning. — Sherwin-Williams Co., Cleveland.

PREHEATER — Pamphlet describing machine for preheating and mixing prepared food products. — Patterson Foundry & Machine Co., East Liverpool, Ohio.

PUMPS—Bulletin W-110-B2, on simplex and duplex, side-pot type, horizontal piston pattern pump.—Worthington Pump and Machinery Corp., Harrison, N. J.

REFRIGERATION—Bulletin W-207-E17, title "Capacity and Design Standards for Steam Refrigeration."—Carbondale Machine Corp., Carbondale, Pa.

REGULATORS—Bulletin No. 83, on feed-water regulators.—Bailey Meter Co., 1050 Ivanhoe Road, Cleveland.

RELAYS — Bulletin No. P72, showing relays, timing devices, electric counters, thermostats, and electric pots and ladles.—Struthers Dunn, Inc., 139 N. Juniper St., Philadelphia.

RUBBER COMPOUND—Two pamphlets on "Selfvulc" a self-cold-curing plastic and liquid rubber compound. — Self-Vulcanizing Rubber Co., 605 W. Washington Blvd., Chicago.

STAINLESS STEEL—Booklet on "Enduro" stainless steel.—Republic Steel Corp., Massillon, Ohio.

SCREENS—Bulletin No. 93, describing "Vibrex" screens.—Robins Conveying Belt Co., 15 Park Row, N. Y.

SKIDS—Bulletin No. 2532, describing steel-leg skid platforms for hand and power trucks. — Barrett-Cravens Co., 3255 W. 30 St., Chicago.

SPRAY COOLING—Two bulletins on forced draft and atmospheric spray-cooling towers for air conditioning and refrigeration.—Binks Mfg. Co., 3106 Carroll Ave., Chicago.

STOKER—Catalogue No. E-8, describing center-retort, underfeed stoker.—Combustion Engineering Co., Inc., 200 Madison Ave., New York.

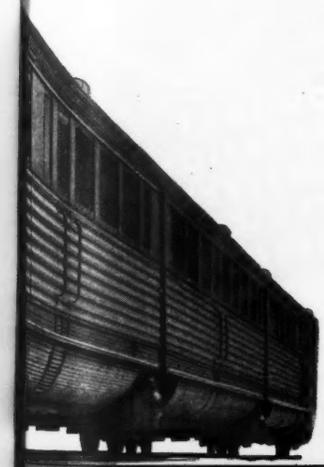
(Continued on advertising page 68)

Economy-Safety

PROMOTED BY

TIDE WATER DIESEL OILS

"Flying Yankee" well describes this first streamlined train serving New England. It is the crack Boston-Portland-Bangor express of the Boston and Maine and the Maine Central. Built by Budd, powered by Winton, lubricated by Tide Water, this modern medium of transportation will be driven by its 600 h.p. Diesel-Electric power plant to speeds well over 100 m.p.h.



At these speeds a solvent-refined oil is essential for full protection to this modern power plant. Tide Water, as a pioneer in the production of solvent-refined oils, is thus the logical selection. A pioneer in modern transportation thus enlists the services of a pioneer in modern lubrication, with the confidence that Tide Water's reputation and experience as a manufacturer of quality products assures.

On land, on sea and in the air, Tide Water Lubricants have won the recognition awarded to leaders in the solution of modern lubrication problems. Those who cannot afford anything but the best are turning in ever-increasing numbers to Tide Water—and remain satisfied users.

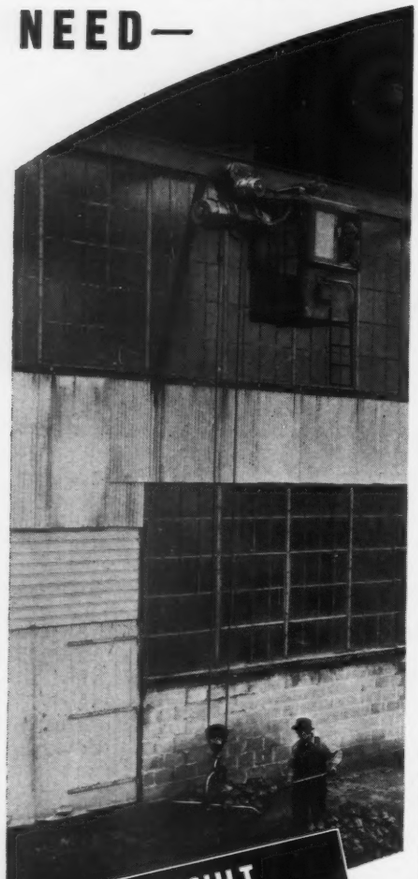
INDUSTRIAL TYCOL OILS-GREASES

TIDE WATER OIL COMPANY

17 Battery Place, New York, N. Y.

A COMPLETE LINE SCIENTIFICALLY ENGINEERED FOR EVERY INDUSTRIAL USE

ADAPTING THE HOIST TO FIT THE NEED—



CONSULT HARNISCHFEGER ENGINEERS ON EVERY HANDLING PROBLEM

This cage controlled 3 ton hoist with motor driven trolley makes an ideal cupola charging unit for the Schwab Furnace & Manufacturing Company. Special long drums can be provided to accommodate all long lift applications.

It's the job of P&H Engineers to study your handling problems . . . and to solve them in the most effective, low cost manner. Write for catalog RH-2.

HARNISCHFEGER CORPORATION
4525 W. National Ave., Milwaukee, Wis.

P&H MILWAUKEE ELECTRIC HOISTS

Trend Toward Weekly Pay

(Continued from editorial page 108)

has saved $4 and the employee is enabled to earn $8 a week more than formerly. Another name for the "white check" list! And here's another. Jones works either piece rate or hourly rate. In any case, he averages 65c. an hour. In 40 hours he has earned his limit of $26 per week, so he is glad to go on a weekly basis at $35 (minimum code salary for unrestricted workers) even if he does put in more hours. What plant manager would not prefer to have four experienced men drawing weekly checks averaging $37.50 per week than hire a fifth man and hold them all down to an average of $30 per week?

Summing up, there appear to be numerous causes for the substitution of hourly for piece rates. Some of these causes explain the even more recent tendency to substitute *weekly salaries* for hourly rates among the more essential and better paid classes of employees.

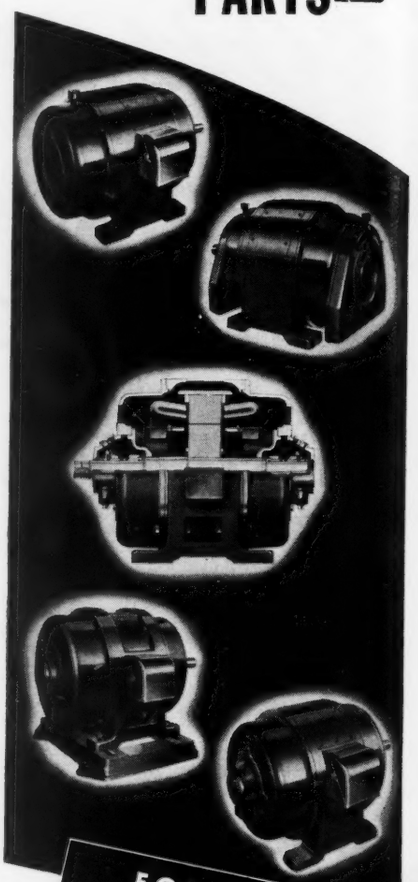
Needless Step Backward

H. A. COZZENS, Jr.
Superintendent,
American Hard Rubber Company,
Butler, N. J.

PERHAPS one field in which the greatest strength of organized labor may be found is in the construction industry. Here, for many years, the pay has been on an hourly or daywork basis, and there would appear to be little doubt that organized labor is very favorable to this type of pay for industrial operations.

In the automobile industry, the machinery is so spaced that goods to be worked upon cannot pile up behind the operator without causing considerable congestion, and even if the pay were to be on a daywork basis there would be an incentive for the operator to keep his space clean, or, in other words, to maintain his efficiency of operation. The case is likewise more acute where the operator is working in connection

INTERCHANGEABLE PARTS—

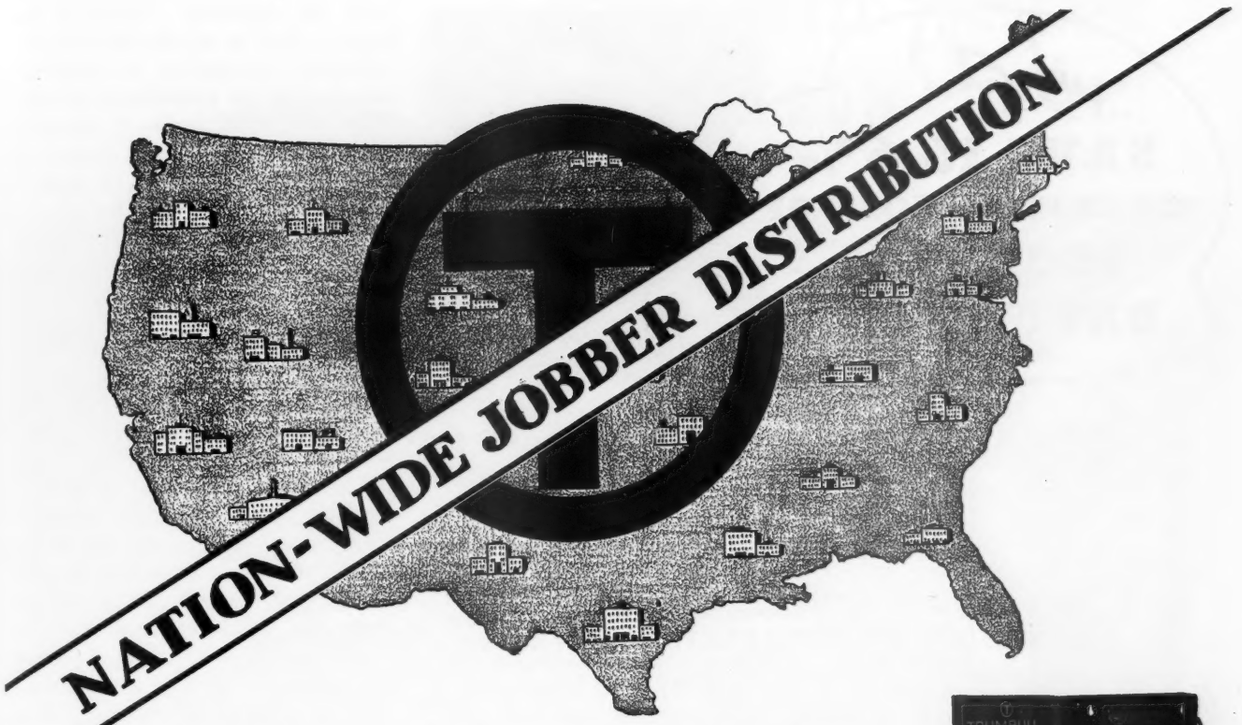


FOR EASY ADAPTATION TO DIFFERENT SERVICE REQUIREMENTS

Here's convertibility in standard AC motors at no extra cost. Enclosed fan cooled, splash proof, or totally enclosed service requirements can be filled with a standard open type unit. Either Squirrel Cage or Slip Ring types. It means extra motor value from the day it is installed. You can correct misapplications without delay. You can avoid costly replacements. Bulletin HM-1 gives you complete details. Ask for it.

HARNISCHFEGER CORPORATION
4525 W. National Ave., Milwaukee, Wis.

P&H CONVERTIBLE MOTORS



assures prompt delivery of "CIRCLE-T" PRODUCTS

TRUMBULL material is sold through electrical wholesalers who warehouse large stocks located conveniently in all parts of the country.

This guarantees local or nearby service to Industry, on the most complete assortment of Enclosed (Safety) Switches, Motor Starters, Open Knife Switches, Circuit Breakers, Panelboards, Power Distribution Boards and other affiliated equipment for complete systems of interior electrical distribution and control, obtainable from any one company in the country.

Industry, therefore, can be served on its requirements for this type of material by one line, of proven quality with a factory guarantee and through one source of supply.

A complete illustrated listing of the Trumbull line is furnished in Catalog 16 containing over 200 pages. Bulletins and Manuals giving engineering data are available on the following:

Switchboard Manual—Showing the new R.B.I. switchboard.

Buss-Wa—The enclosed Busbar distribution system.

Flex-a-Power—The convenience outlet for power in Industry.

ConverTi-Fuse—The Dead-Front Unit Panelboard for Convertibility and Safe Fuse Replacements.

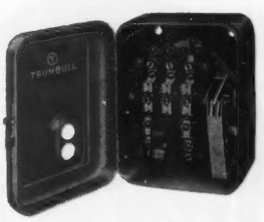
Controlite—A control switchboard for stage and auditorium lighting.

Any of these promptly sent on request.

THE TRUMBULL ELECTRIC MFG. CO.
PLAINVILLE A GENERAL ELECTRIC ORGANIZATION CONN.

SAFETY SWITCHES

Type "RB"—Front or side Operated.
Type "A"—Single and Double Throw.



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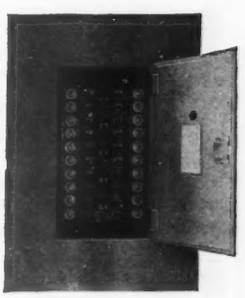

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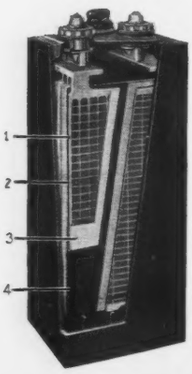

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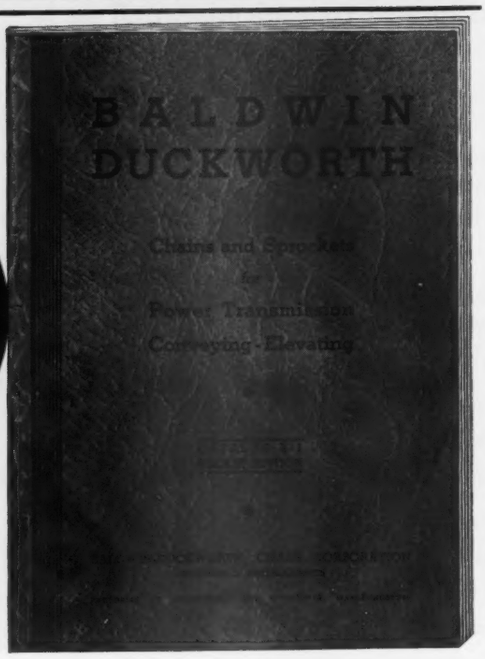

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Get the answers today. Have data on the right chain to use for different horsepower and speed conditions as well as other valuable information at your finger tips.

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with the conveyor. There is perhaps no field in which the task is so definitely outlined or so accurately timed as in the automobile industry.

In most other forms of industrial enterprise we do not find similar conditions, and some form of incentive system is required in order not only to maintain production but to be able to sell the product in competitive markets.

Guarantee Against Interruption

All piecework plans are not so designed that the operator is penalized for interruptions. A guarantee, somewhat approaching his earned rate, can be arranged so that the man will not be penalized for conditions beyond his control. A decision of the National Industrial Recovery Board just recently given out protects the employee from interruptions beyond his control and provides for payment during such periods. This decision should remove a source of complaint by employees in the automobile industry.

The main question in the average industrial enterprise arising from payment on a daywork basis is whether or not the increased labor cost will be collectible.

Penalize Speedy, Overpay Sluggish

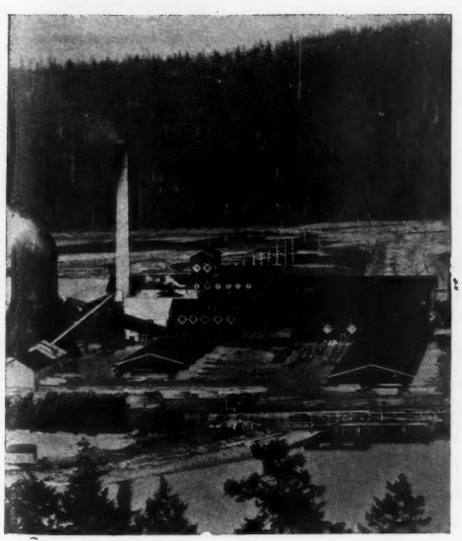
Under incentive systems the operator has just what is implied—an incentive to work faster than his neighbor, and he often reaps the entire benefit of his extra effort. If all men are placed on the same hourly basis, the fast worker will be penalized and brought down to a lower level and the slower worker will naturally be overpaid. Only very close supervision will correct this condition, and such supervision is not at all times possible.

It is doubtful whether articles will be produced for the same labor costs at hour rates, and there is no reason why labor and management cannot get together to provide a system of payment which will be just to the workmen and yet not revert to the daywork system from which we have graduated during the past decade or two.

NEARLY THREE THOUSAND MILES FROM "HOME"

A BUSY lumber mill, on the big water north of Seattle. Steady operation was imperative; no time to wait for new parts in case of breakdown. So, when Cleveland got the original contract for Power Drives, another order—for replacement parts—came right along with it.

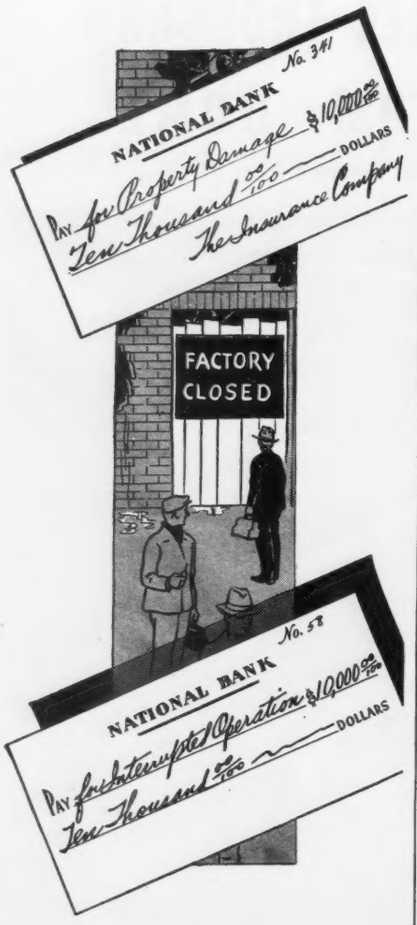
Eight years passed. No word. Then, one day, came the news that all those original drives, through all those years, had done their job without a falter. Not a single replacement had been necessary in any one of the Clevelands installed.



In other words, Cleveland Worm Gear Units "had what it takes;" always have had; always will. For 23 years, Cleveland has been building Worm Gear Drives exclusively, by the most exact, painstaking methods.

Why not apply the results of that fine experience, to the power drive requirements of your own business? A Cleveland District Engineer will gladly call. Please consult your telephone book, or address The Cleveland Worm & Gear Company, 3256 East 80th Street, Cleveland, Ohio.

CLEVELAND
WORM GEAR *Speed Reducers*



THE UNSIGNED CHECK

THE fire menace knows no respect for size or fame—it strikes at will. Result—Your property damage may be covered by an insurance company check, but who signs the check for interrupted operations, loss of orders and service?

Today, if you have a lacquer, gasoline or electrical hazard in your plant, it is easy to buy protection that will prevent tie-ups from fire in that plant.

LUX extinguishers will put out fires in flammable liquids against which ordinary fire equipment is powerless. LUX smothers fire with an inert gas instead of a liquid. It is instantaneous and three dimensional in its extinguishing effect—Clean—Dry—and Harmless to Man or Material. Yet LUX snuffs out fires involving gasoline flowing through the air from leaking pipes or overflowing tanks against which foam and carbon tetrachloride fail.

Write for information to Dept. A-3, Walter Kidde & Company, Inc., 60 West Street, Bloomfield, N. J.

LUX **For All Electrical and Flammable Liquid Fires**

Maintaining Belt Tension

(Continued from editorial page 132)

tion with more frequent take-ups.

When there is an outboard bearing on one or both sheaves, these bearings must be dismantled to install or replace V-ropes. To avoid this difficulty, a kickout block may be provided under a bearing pedestal.

The Pivoted Motor Base

A more recent development in belted short-center drives is the pivoted motor base. If adjusted when installed to give the required tension, this drive will maintain it automatically for months, or years, in spite of belt stretch. When the limit of automatic adjustment is reached, the drive may be reset while running without altering the original tension adjustment.

Figure 4 illustrates the principle of the drive, whereby belt tension is balanced against part of the motor weight. The portion of motor weight so balanced against the belt tension is adjustable through wide limits by altering the position of the pivot shaft.

Types of Pivoted-Base Drive

Pivoted-base drives are built in several forms. When the motor is mounted directly above the driven pulley, the gravity-operated drive is inapplicable, and a spring-loaded design is used. A third type has been designed for ceiling installation, usually with group drives.

This form of drive maintains adequate tension automatically in spite of belt stretch and removes the temptation to impose excess tension at time of take-up so as to lengthen the period between take-ups.

From what has been said in this and the preceding article it will be evident that there are available for almost any application one or more types of mechanical transmission capable of giving long, trouble-free service. Misapplication of any of them will result in trouble. Each is excellent in its place. None has universal applicability.

[A succeeding article will discuss the proper planning and installation of short-center, flat and V-belt drives. —Ed.]

Obviously the safe, sensible, sure way to oil a pneumatic tool is to lubricate the air stream. Until now you haven't been able to do that properly. Even now, there's only one way—attach a Norgren Sight Feed Automatic Lubricator to the air line. Then the air slips along smoothly, carrying just the right amount of lubrication to every moving part.

Sight feed, adjustable, positive, continuous in operation, easily installed. No upkeep cost.

No installation ever made has been taken out! Sizes range from ¼ in. to 1½ in., prices $5.00 to $24.00. Two styles, horizontal and vertical. We'll ship on the order of any rated company, allow 30 days' trial, accept return of shipment if customer is willing to operate without it!

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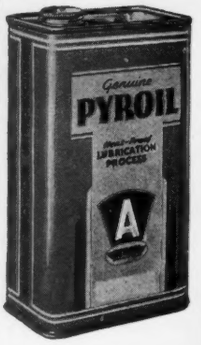

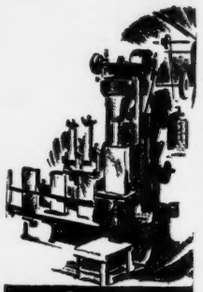

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This famous lubrication process is adjudged of paramount importance in controlling friction and in dispersing operation problems attributed to friction difficulties.

We should like an opportunity to suggest in what manner Pyroil can be of definite value in meeting lubrication problems within your institution. Pyroil easily saves far more than its cost. Just mail the coupon, specifying your requirements. No obligation whatever. Manufactured and Guaranteed by Pyroil Company, W. V. Kidder, Pres., 620 LaFollette Ave., LaCrosse, Wis., U. S. A.

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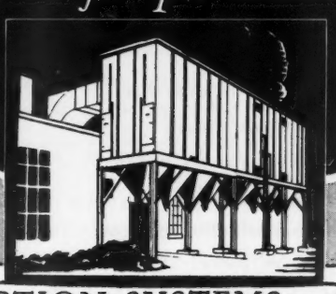

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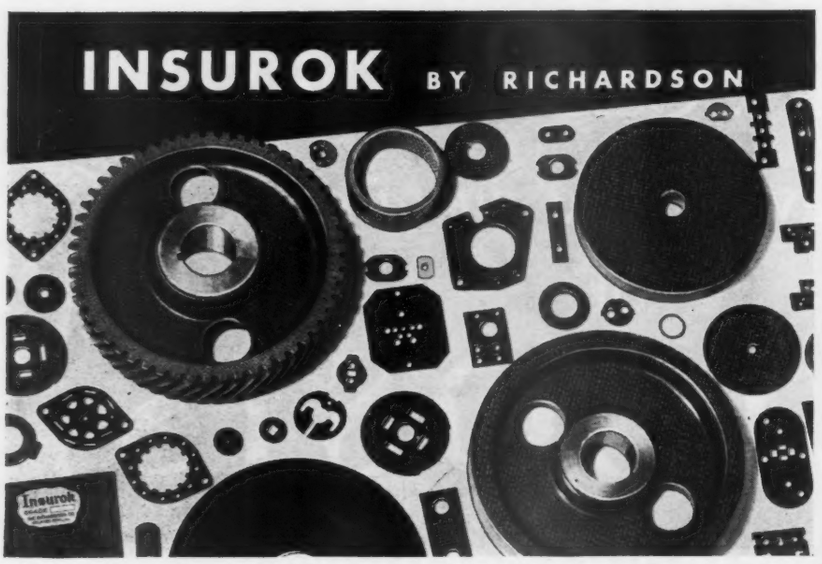

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INSUROK chemically resists most reagents, acids, solvents, oils and other liquids. Does not corrode nor deteriorate but rather improves with age.

INSUROK is available in a multitude of forms of a grade and thickness for every service . . . for unusual toughness . . . for severe mechanical service . . . for high dielectric, as well as in a wide range of colors and finishes to suit varying applications.

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The Richardson Organization, the largest in the United States devoted exclusively to the plastic arts, offers you (as custom molders of all forms of synthetic resin plastics) the services and cooperation of its Research Laboratories, Design and Engineering Departments.

The RICHARDSON COMPANY
Melrose Park, Ill. New Brunswick, N. J.

FOUNDED 1858

Let's Look Into Electron Tubes

(Continued from editorial page 124)

and open circuits when the grid is made positive or negative. A Pliotron tube can open the circuit at any time, but the Thyratron cannot open a d.c. circuit at all unless excessive, impracticable potentials are used. It can open an a.c. circuit during the negative half-wave. This tube opens the circuit by preventing a restart when the anode again becomes positive.

Relaying operations with tubes are numerous and varied. A change in light intensity on a phototube can be relayed to operate a lighting switch or a solenoid. A slight movement of a reactor core can be relayed by a Thyratron tube to change the speed of a motor.

Rectifying is the normal function of all these tubes; they are one-way-traffic devices. Current cannot pass from cathode to anode; hence only positive half-waves are passed. From an a.c. source Thyratron tubes can furnish direct current for the armature circuits of small d.c. motors and for the field circuits of motors rated up to several hundred horsepower. Battery charging is a duty of the Phanotron tube.

Amplification is accomplished in various ways. The output of a tube may be applied as grid control to the next tube and the output of that to a third. Or, tube output may be used to operate a relay in a power circuit. Again, a tube may furnish direct current for a saturable reactor to control high current values.

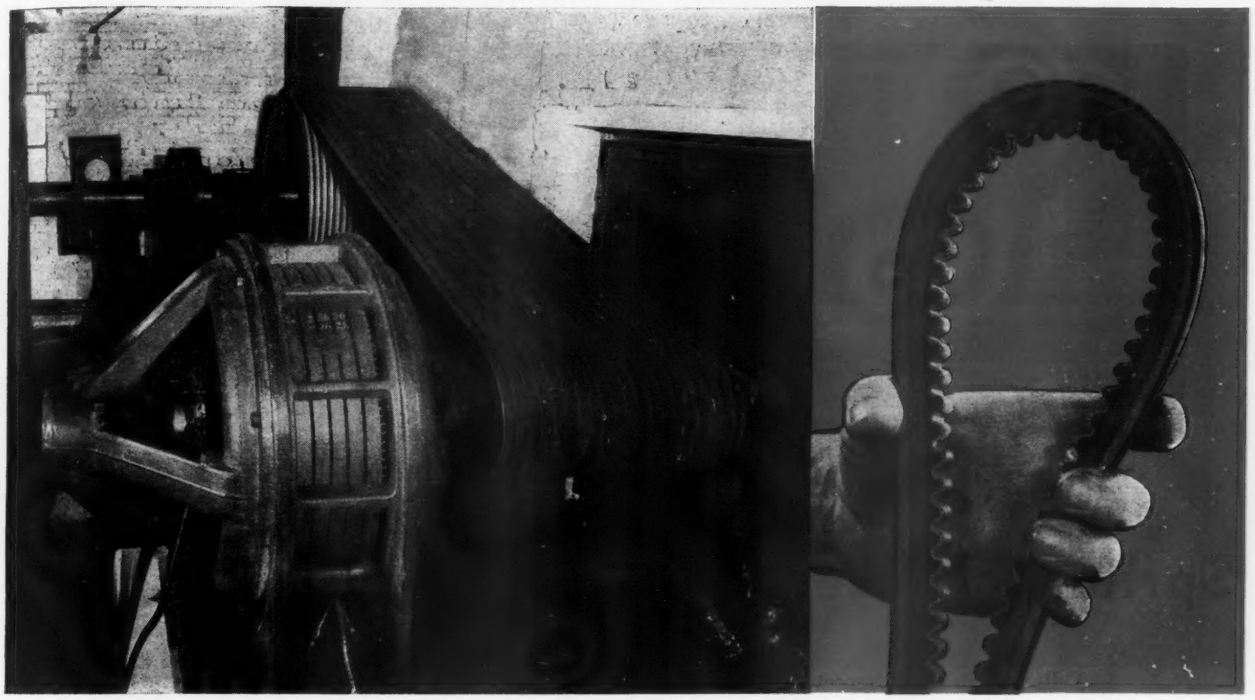
Rheostatic effects are obtained by grid control, by the control of light, or by the secondary effects of the accessories used.

(A second article, scheduled for an early issue, will discuss a wide variety of practical industrial applications of electron tubes.—Ed.)

As We Go to Press

Simon & Schuster, 386 Fourth Avenue, New York, N. Y., announce "Inflation Ahead! What to Do About It," by W. M. Kiplinger and Frederick Shelton. An important book at any time. Especially important now in view of the Supreme Court's gold decision. Price, $1.

DAYTON COG-BELT DRIVES effect unusual savings in Power _Operating Costs_Floor Space



●The only V-Belt that is specifically Built-to-Bend. The scientific construction of these belts makes possible the amazing performance of Dayton Cog-Belt Drives

●The installation of Dayton V-Belt Drives has enabled plant and production managers to solve many troublesome and unusual power transmission problems. In addition, savings amounting to thousands of dollars a year have been effected.

A striking example of savings that can be effected is found in a coal mine Ventilating Fan Installation. The original drive had a center distance of 25 feet. The edges of the belt were being constantly torn by rubbing on the wall of the building. This drive was replaced with a Dayton Cog-Belt Drive with a center distance of only 10 feet. This change not only saved belts and space but it also eliminated the constant danger of drive failure. The Dayton Cog-Belt Drive was found to be in perfect condition after a long period of continuous running.

Similar savings have been made in plants of all kinds where Dayton V-Belts have been installed. Here are some of the reasons why: Dayton V-Belts are "built-to-bend." Their exclusive and patented construction makes them more flexible. They are die-cut, not molded, and accurately fit the grooves of all standard pulleys. Their rigid crosswise construction prevents distortion—there is no slipping or weaving. This means smoother running . . . positive speed . . . less tension . . . less wear on bearings. Machines last longer and there's practically no maintenance cost.

But there's much more to tell. Let us give you all the facts about the many exclusive advantages of Dayton V-Belt Drives. Wire or write today.

THE DAYTON RUBBER MFG. CO.
Dayton, Ohio
The World's Largest Manufacturers of V-Belts

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COG-BELT DRIVES

Cog-Belt Drives—F.H.P. V-Belt Drives—V-Flat Drives—Complete Drives, Pulleys and Belts in Stock. Fractional to 100 H.P.

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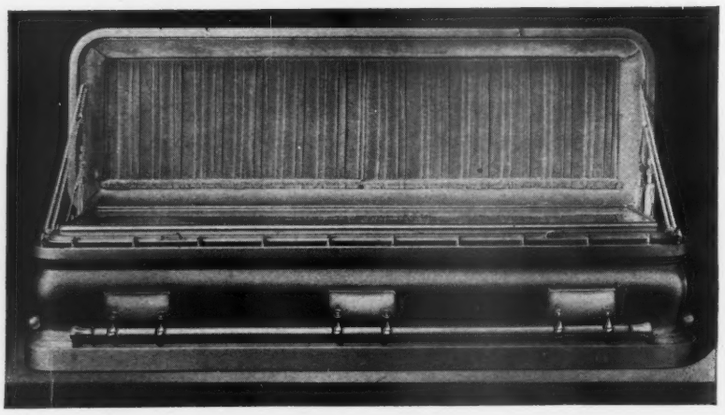

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Progressive manufacturers know that DeVilbiss Equipment does better work, in less time, at lower cost. Higher quality finishes effect improved appearance, which increases the sales appeal of your products. More efficient finishing methods save time, thus reducing costs.

Near you is a DeVilbiss representative, well qualified to help you in all matters relating to finishing. Let him explain the newest developments in DeVilbiss Spray-Finishing and Exhaust Equipment. You will be interested in his recommendations. Call him, or write us direct.

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Direct sales and service representatives available everywhere

DeVilbiss

Selling the Layout

(Continued from editorial page 100)

somebody is going to get some good ideas before discussion has gone far.

On a recent layout job, one conveyor company sent a representative with some motion pictures of various installations. At first, the whole plant group were much opposed to mechanical handling. They had been burned once. They started in to criticize, stayed to discuss, eventually developed a plan better than any suggested by the engineers, and put it over. An equipment manufacturer showed a film of a new installation in an automobile plant. While not directly applicable, the enthusiasm this engendered has been responsible for the acceptance of many ideas hitherto considered impractical.

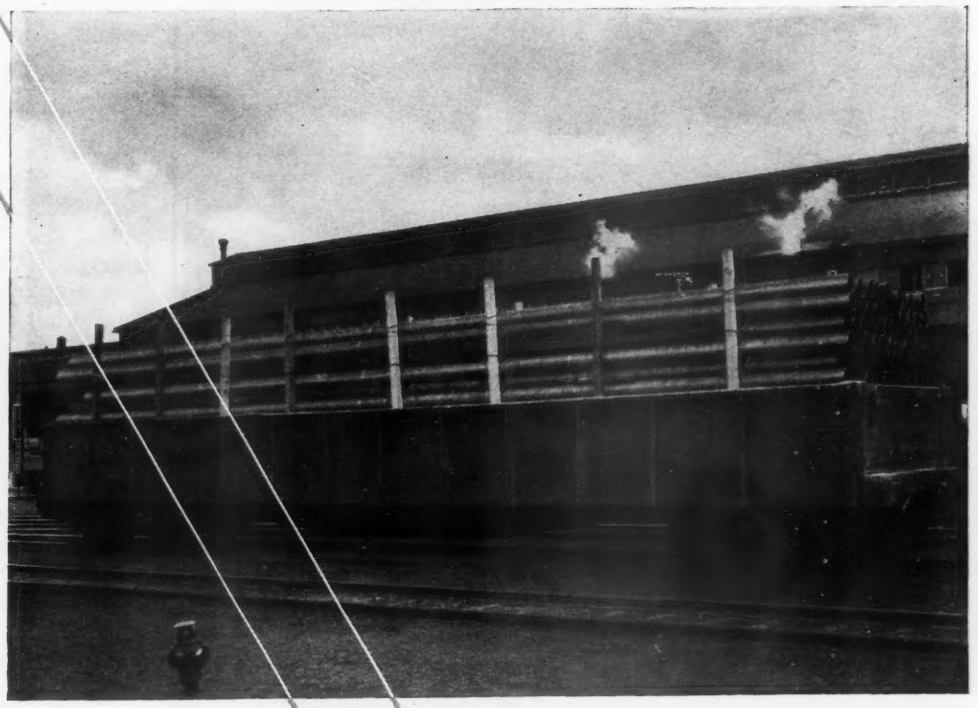
But to return to selling management. Make a complete summary of all savings. All those that can be translated into dollars and cents should be tabulated. Intangibles should be listed, if important. Against this, list all costs of making the move. Work out the return on the investment, in per cent. Write the report, giving the facts in a one-page summary.

Talk About Earnings

Forget that you are presenting a project for a plant rearrangement. Make a presentation that looks like a statement of earnings possibilities on a new stock issue. Then follow with your process charts, flow diagrams, *and the facts.* One of the most successful men in the machine-tool industry today does not talk bearings, feeds, and speeds, but goes direct to the executive head of the company and asks him if he is interested in an attractive return on invested money.

If there are several possibilities up for consideration, or if the project lends itself to logical divisions, each one should be figured separately on a return basis. When the layout is accepted, a plan for moving should be made, each step scheduled, and construction drawings started from the templet layouts. After the move has been completed, the templet layouts should be brought up to date, and kept that way. Thus changes can be made on the boards, and plant layout will be dynamic—not static, as in the past.

FOR THOSE WHO WANT PIPE IN LONG LENGTHS



THERE are times when pipe in long lengths is a boon —when industrial heating, plumbing and power lines are being built or remodeled and long runs are necessary, when large expansion bends must be made, when piling for the support of heavy work floors must reach a considerable depth. Republic's patented electric weld process makes pipe that is ideally suited for this class of work.

It is available in lengths up to fifty feet without any mid-weld and in sizes 2⅜″ O. D. to 16″ O. D. It is straight, round and of uniform size and wall thickness. It differs from lap weld pipe in that it is made from flat-rolled steel (or Toncan Iron where conditions dictate pipe with high corrosion-resisting qualities) formed cold to a perfect round, and then welded by electrical resistance without the addition of foreign metal. The resulting weld is as strong as the wall of the pipe.

Republic Electric Weld Pipe has established a fine record in the petroleum industry where conditions of service nine times out of ten are far more severe than in other industries. There's a place in your plant where its unusual qualities will make it more economical than your present pipe practice. Let us send you more detailed information.

REG. U.S. PAT. OFF. TONCAN COPPER MO·LYB·DEN·UM IRON PIPE

REPUBLIC ELECTRIC WELD PIPE

REPUBLIC STEEL CORPORATION

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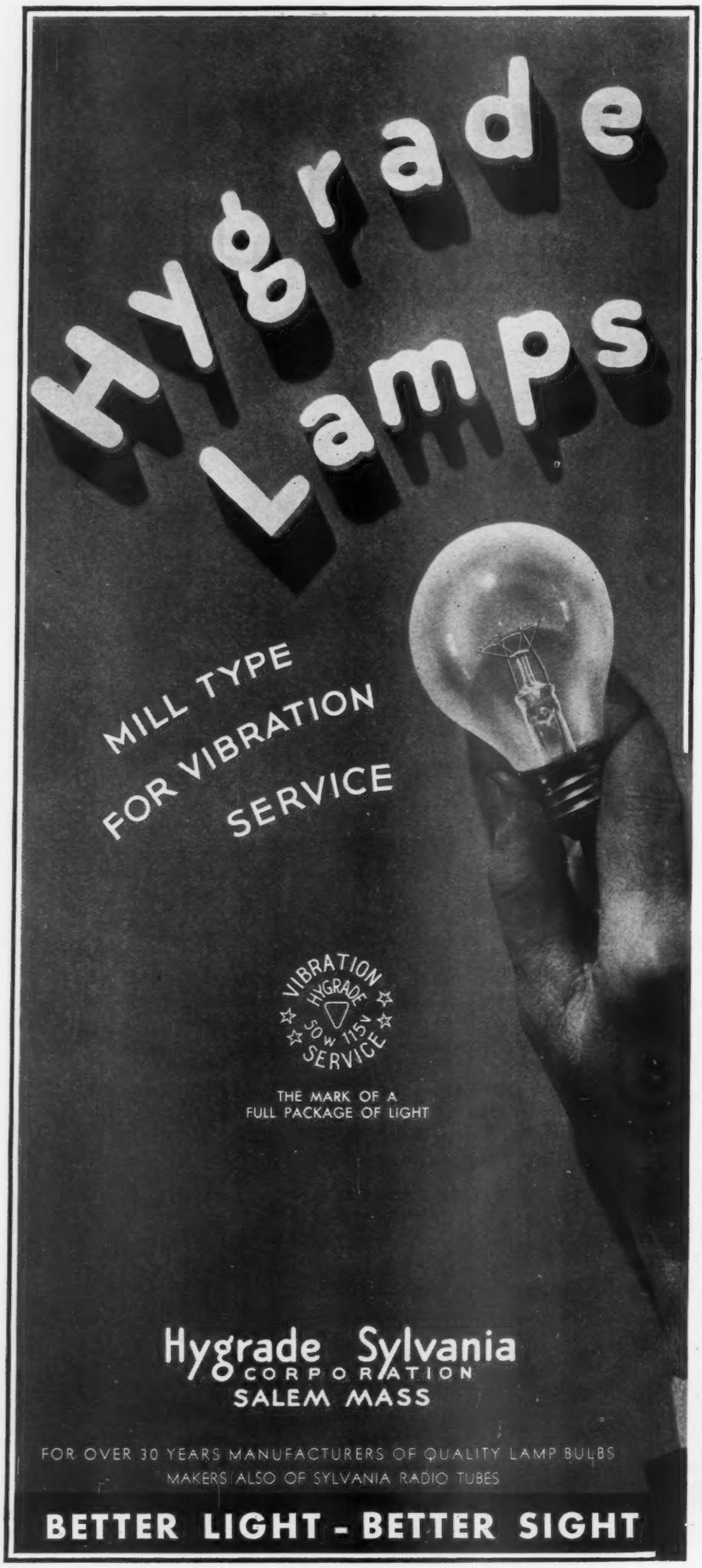


An Okay on Research

(Continued from editorial page 110)

One such incident led to another, so that the controls went in as assistance desired by the operating men rather than as an interference imposed against their will. One plant manager remarked that, if he had to step out of his plant, his chief chemist would be the logical man to take his place. The laboratory has proved a good seed bed for developing operating supervisors and executives.

Meetings of technical directors of all plants as well as of the various plant staffs are held at regular intervals. These gatherings provide for an exchange of ideas, make for uniformity of methods and standards, and provide a stimulus to—and recognition of—good work and achievement.

Steadily increasing sales, better quality, lower costs and better profits have proved the value of the program as the right answer to unintelligent price competition. To do away with research and the controls it makes possible would be like turning off the lights and trying to find the way in the dark.

Questions and Answers

(Continued from editorial page 137)

tween the brush-holders and the commutator affect the chattering in any way? How can I clear up this trouble?

C.E.—San Diego, Calif.

BRUSH chattering such as reported is known as tangential chattering; that is, the brushes do not jump vertically, but vibrate backward and forward. The most likely cause is the wrong brush angle, although it may not be the only one. We recently had the same trouble on a 100-kw. generator, and other steps in addition to correcting the brush angle were necessary to clear it up.

If the brush-holder clearance is considerably greater than it was originally, lower the holders; then change the brush angle so that it is not more than 10 degrees with a line passing through the shaft and the center of contact of the brush.

In our case the use of harder brushes was also necessary. Experiment showed that by using the harder brushes in

Hammond's Clock's McCaskey Inventory Control System

DEPENDABLE
—That's McCASKEY Control

Read a factory manager's 1935 statement—

This is one of numberless cases where McCaskey perpetual inventory control methods give dependable record information when and where needed—instantly.

The McCaskey eclipses other methods in speed and dependability of information by visibility and simplicity of record cabinets and "One Writing," multiple copy forms.

It brings you in seconds what minutes and hours of time accomplish by other systems.

Its success is equally established in production and machine control, in tool checking and tool investment control.

Check at once for the value of the savings and information McCaskey is prepared to bring to your plant—it is too BIG a value to overlook.

Factory Manager
A. H. LESSER of
The Hammond Clock Co.,
Chicago, Ill.
says:—

"In the manufacture of 'Hammond Electric Clocks' a dependable perpetual inventory control is essential.

"Six years ago we installed the McCaskey perpetual inventory system to take care of our raw, semi-finished and finished stock records, some 4,000 items.

"The complete and accurate stock record maintained by the McCaskey system is a valuable guide in making purchases of stock and checking their delivery.

"From these records we plan and schedule our production. In fact these records are the center of our factory control.

"The 'One Writing' feature and the visible records enable us to handle a large volume of transactions with a minimum of clerical help. Our records are accurate and always up-to-date."

THE McCASKEY REGISTER CO., ALLIANCE, OHIO INDUSTRIAL DIVISION 1035

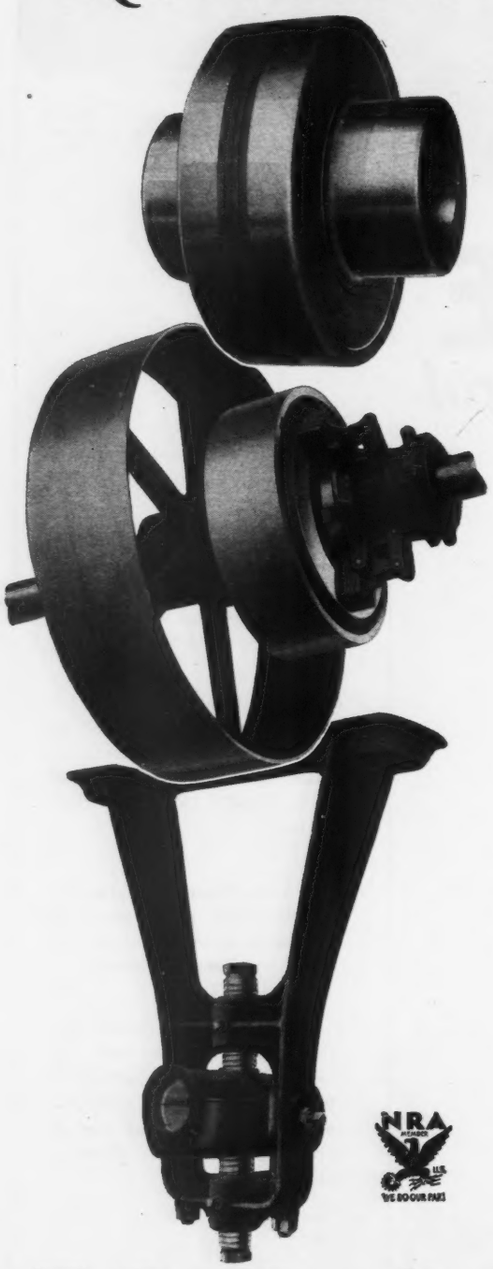
Galt, Canada Watford, England

McCASKEY ONE WRITING SYSTEMS

"Standardize" on

WOOD'S

GROUP DRIVE EQUIPMENT



After all, doesn't it seem like a wise move to buy your Group Drive Equipment from *one source* of supply? Particularly so if that one source is backed by long experience, adequate shop facilities and enviable reputation.

Under the present scheme of things, profits are largely dependent upon low cost of production, and one positive means toward lower production costs is accurate, dependable power saving transmission equipment.

For nearly 80 years, we of T. B. Wood's have directed our energies along one channel, that is, GOOD, RELIABLE TRANSMISSION EQUIPMENT.

Ask for literature on any (or all) of the following nationally known WOOD LINE:

WOOD'S PRODUCTS

Shafting, Hangers, Collars, Pulleys, Friction Clutches, Ball Bearings, Flexible Couplings, Rope Sheaves, Pillow Blocks, Belt Contactors, "V" Belts, "V" Belt Sheaves and complete "V" Belt Drives.

T. B. Wood's Sons Co.

NEW YORK 30 Church St. Chambersburg, Pa. BOSTON 387-391 Atlantic Ave.

MEMBER—THE MECHANICAL POWER ENGINEERING ASSOCIATES

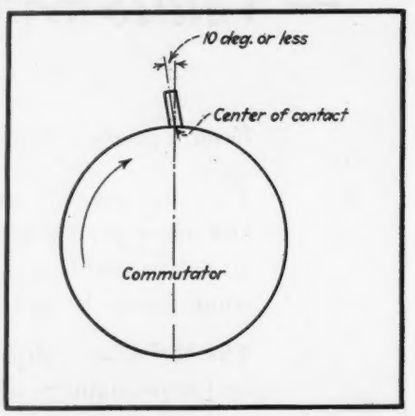
all of the holders for one polarity and the softer brushes in the holders of opposite polarity we could avoid excessive wear on both commutator and brushes, and eliminate the chattering.

It may also be found that only a few of the brushes are chattering. In such an event I bevel the tops of these brushes with a hacksaw at the point where the spring rests, and at an angle opposite to that of the face. This procedure will often stop chattering.

If a mixed set of brushes is used, be sure that they are not mixed in holders of the same polarity. Very few different types of brushes have the same specific resistance; hence, if two different types are used in holders of the same polarity unequal current division and poor commutation will result.

ROY M. STINSON, *Operating Engineer Rock Island Lines, Chicago*

SEEMINGLY the brush setting is wrong, even though the brushes now point in the direction of rotation. The setting should be such that the angle of the brush with the radial line passing through the center of contact is 10 degrees or less. If it is more than that there is likely to be trouble. The diagram will make this point clear.



Sometimes when a commutator is turned down in a lathe at low speed it will run perfectly true, but when run at rated speed in service the bars will rise slightly, due to the greater centrifugal force. To correct this condition the commutator clamping ring should be tightened.

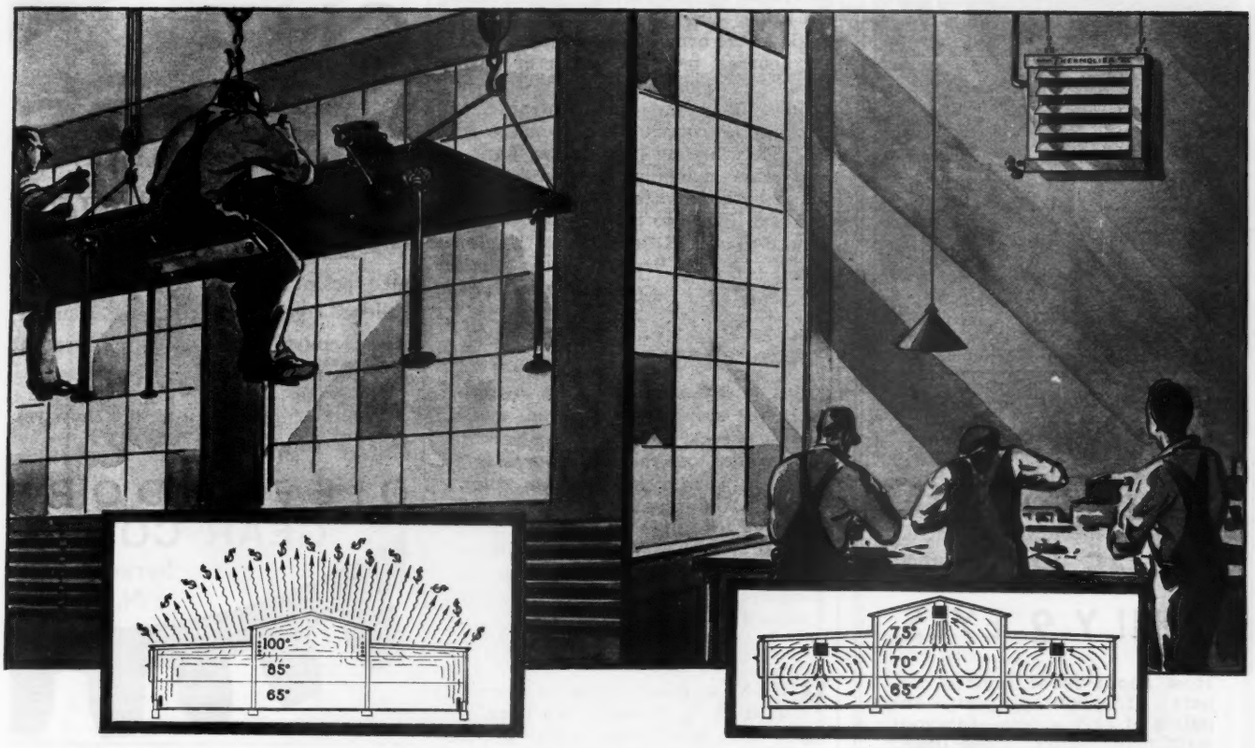
Other causes of chattering are: (1) Brushes having too high friction. (2) Brushes that are too thin. (3) Brushes that are too loose in the holders. (4) Vibration due to loose bolts; unbalanced armature; bent shaft; driving pulley out of round; vibration from prime mover.

Small clearances between the brush-holders and commutator lessen the tendency to chatter. For the best results the holders should be from 3/16 to ¼ inch from the commutator.

CLARENCE W. HOPE, *Lowell, Mass.*

THIS trouble may be due to lack of lubricating effect; hence, a softer brush (containing more graphite) might help. As an experiment C.E. might boil the present brushes in

Two ways to CUT HEATING COSTS



You can retain an antiquated heating system and raise your workers to the ceiling where most of the heat is now wasted;

Or you can substitute Thermoliers and *force the heat down* where you want it. The result is an even distribution of heat with savings of 30% and more in heating costs. The experience of hundreds of plants that have been modernized with Thermoliers is offered as proof.

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paraffin wax for an hour and when replacing them set the holders closer to the commutator so that the clearance is about ⅛ inch. Greater clearance than this will tend to produce chattering.

Sometimes chatter and noise can be overcome by increasing or decreasing the brush spring tension; changing the angle of the brush-holders and resetting the neutral; use of a softer or harder brush; using brushes that are a snug sliding fit in the boxes; turning and stoning the commutator, to make sure that there are no high or low bars.

If this machine has recently developed the chattering, high or low bars are likely to be the cause.

LIONEL A. HUNT, *Service Engineer*
Bepco Canada, Limited
Toronto, Canada

Wash or Paint?

A question has come up regarding the economy of washing walls and ceilings, instead of repainting. Our office and factory departments are painted a light cream color. The paint now looks dingy, although it appears to be in good condition otherwise, and something should be done to it. How do washing and painting compare in regard to cost and results?

K.C.G.—Newark, N. J.

WHEN a good grade of paint is used it is usually practicable to wash it at least twice before repainting is necessary. A small area can be washed with a sponge, using soap and water, to serve as a sample from which it is possible to determine whether a washing job will be satisfactory.

In factories where the walls become badly stained with smoke or chemical fumes it is best to repaint, but in offices or warehouses washing is usually the more economical. Use of a spray gun for factory painting will greatly reduce costs. The purchase of cheap paints is poor economy; only high-grade materials should be used.

Costs will vary in different parts of the country, but in St. Louis it is possible to have paint washing done very cheaply by certain firms that specialize in this kind of work. They do the work more economically than ordinary factory laborers not experienced in this line.

CARL W. SCHWABE
Supt., Mechanical Dept.
Mallinckrodt Chemical Works, St. Louis

PROBABLY many plant engineers have asked themselves the same question, because any company that considers that good working conditions mean better work by the employees is interested in it.

A number of factors enter into the problem; so a definite statement that one method or the other is cheaper cannot be made. In various parts of the same plant the answer may be different. Some of these factors are:

1. The material to be washed or painted.
2. Its condition.

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You specify—we'll quote, and show you what Prompt Service means.

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Idle Time of Machinery!

Do you know EXACTLY how much on each machine ?

A—Didn't get started until 9 A. M.
B—Stop of 40 minutes—waiting for material.
C—A hearty lunch!
D—Three 10-minute stops—machine jammed, poor material.
E—Operative left machine for half an hour. Why?
F—Plenty of time to wash up! Quitting time not until 5:00.

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See how "time down" stands out on the chart above. You can't miss it. You can't help but reduce it!

Suppose you could reduce idle time on all your factory machinery nearly 10 minutes a day! What would it amount to in a year—or even a month! More than you'll ever save by "little economies."

This little "time clock for machinery," the *Servis Recorder,* bolts or clamps right on to the machine itself—no ink, no pencils, no electric wires. Send for folder, "A Busy Plant."

THE SERVICE RECORDER COMPANY
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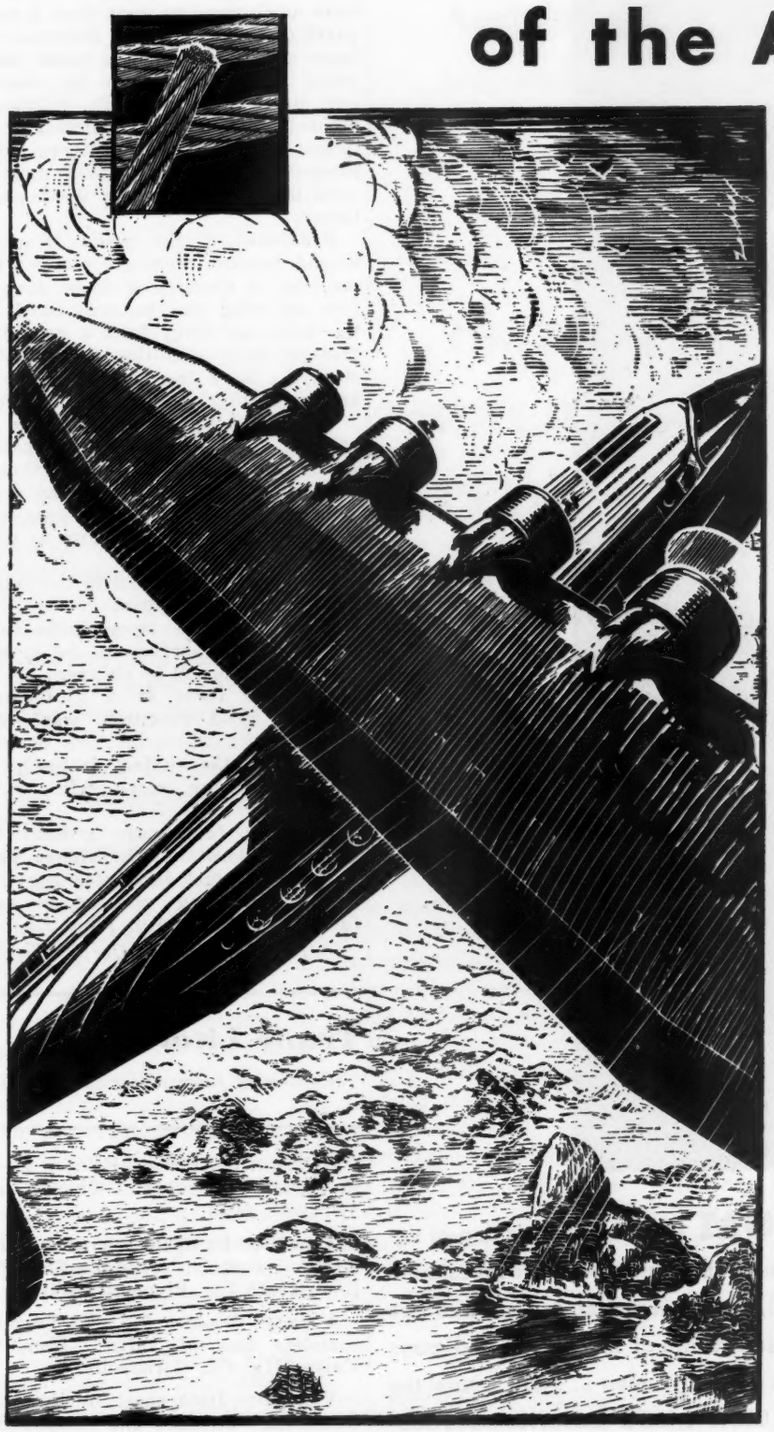
THE SERVIS RECORDER
The "Time Clock" for Machinery

The Clipper King of the Air!



TO MAKE CERTAIN that Roebling Wire Rope will give the user the highest obtainable degree of safe, economical service, Roebling has enlisted the aid of the finest and most complete research, testing and manufacturing facilities. Roebling Equipment for making acid open-hearth steel is an example. John A. Roebling's Sons Company, Trenton, N. J. Branches in Principal Cities.

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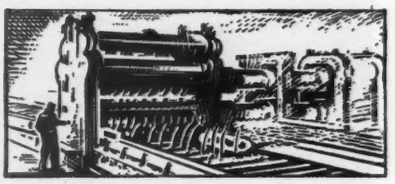
Imagine a mammoth flying boat... carrying 32 passengers, a crew of six, over a ton of mail and express... and capable of flying 1250 miles without refueling. That's the "Brazilian Clipper"... holder of all ten world's records for transport seaplanes. It is one of three identical new Pan-American Airways' ships built by Sikorsky... the greatest of all trans-Atlantic type planes so far developed.

Designers selected Roebling Wire Rope for controls of all three ships. Almost a half mile of rope per ship.



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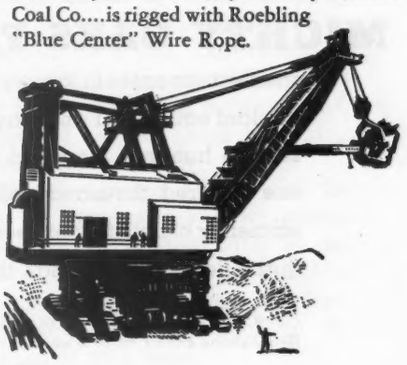
an 18 cu. yd. "Marion", operated by Clemens Coal Co.... is rigged with Roebling "Blue Center" Wire Rope.



ROEBLING ...THE PACEMAKER IN WIRE ROPE DEVELOPMENT

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If you want to get the facts about your lighting, let a trained local utility representative or a G-E lighting expert make a survey of your plant. Simply write to General Electric Co., Nela Park, Cleveland, Ohio.

GENERAL ELECTRIC
MAZDA LAMPS

3. The quality of the paint previously used and to be applied.

The material to be treated is placed first, because of the very wide difference in the cost of washing various materials. A brick wall, for example, costs much more to wash than a metal partition. The same difference in labor cost exists when a paint job is done. Accurate figures on washing and painting brick walls indicate a decided advantage in painting. Between these types are others where personal experience or skill must be used to determine which treatment is better.

Condition of the walls is placed second, because there are places where washing or cleaning must be done before painting can be considered. If the walls are dingy from a greasy deposit or sooty condition they must be cleaned. Here the answer is obvious and no further question can be raised.

Quality of the paint influences the answer, since the cost of washing a glossy finish is much below that of treating a flat finish. Covering power of the paint also influences costs, since some paints cost much more to apply than others.

Our observations lead to the following general conclusions:

1. Where there is a well-covered, fairly smooth surface to be treated, a washing job will be cheaper.
2. Where there is a glossy-finish paint in good condition, washing is cheaper.
3. Where the surface is badly discolored washing alone will not be satisfactory.
4. Where fumes are present that cause discoloration of ordinary paint, or where special fume-resisting paint is used, washing will not be satisfactory. J. P. SIMONS, *Plant Engineer*

Industrial Rayon Corp., Cleveland

Trade Literature

(Continued from editorial page 140)

SYNTHETIC RUBBER—Folder, on synthetic, oil-proof rubber.—Thiokol Corp., Yardville, N. J.

TRACTOR—Pamphlet showing "Silver King" industrial tractor.—The Fate-Root-Heath Co., Plymouth, Ohio.

VALVES—Booklet No. 37 describing complete line of valves.—Homestead Valve Mfg. Co., Coraopolis, Pa.

VARNISH—Data sheet, on the use of insulating varnishes and compounds.—John C. Dolph Co., 168 Emmett St., Newark, N. J.

WASHERS—Handbook, title "Special Washers and Stampings."—Wrought Washer Mfg. Co., 2100 S. Bay St., Milwaukee.

WRENCH—Bulletin, "Announcing the Ingersoll-Rand Pott Impact Wrench."—Ingersoll-Rand Co., Phillipsburg, N. J.